Forming research skills of postgraduate students

Yuliya Bakina†, Galina Smirnova† & Olga Shebalina‡

Abylkas Saginov Karaganda Technical University, Karaganda, Kazakhstan†
L.N. Gumilyov Eurasian National University, Astana, Kazakhstan‡

ABSTRACT: The article presents the results of a pedagogical experiment on the formation of research competencies among postgraduate students in engineering at a Kazakh university. The authors consider the concept of readiness for research activity and its content, and describe the motivational, operational and procedural interconnected components of its structure. A comparative analysis of the results of a confirmatory and formative experiment on the implementation of an additional scientific and educational programme in the control and experimental groups based on the Wilcoxon test is presented, the stages of the implementation are described, and evidence of the effectiveness of the proposed tools is obtained. The main goal of the experiment was to develop readiness for independent development and implementation of scientific research within the framework of one's own Master's thesis. The achieved results indicate that postgraduates in the experimental group can carry out research activities at a higher level than the control group, they less often resort to the help of a supervisor, show more independence in choosing a topic, research methods, setting tasks and describing the results of research activities.

INTRODUCTION

In the conditions of socio-economic modernisation of Kazakhstan and global world transformations, the development of science and innovative technologies, the country's competitiveness and the priorities of domestic science must be determined in accordance with international requirements and national interests. Breakthrough directions of innovative development are based on the rapid development of priority industries, the creation of several development clusters that have great potential for advancing the country's competitiveness. Currently, many highly qualified workers are required, who must have a wide range of competencies and competitive skills developed in the education system. In the situation of integrating science, education and production, the requirements for the training of specialists in engineering and technology, who have the skills of comparison, analysis, synthesis and search for optimal solutions, are increasing.

In 2021, 21,617 scientific workers were registered in the field of science in Kazakhstan, among whom 17,092 were research specialists. It is noted that 35% of them had scientific or academic degrees. In 2022, co-operation between 11 universities and research institutes was strengthened with the aim of increasing the attractiveness of scientific schools, developing research capacity and improving the competitiveness of their members. As part of the co-operation, representatives of research organisations are involved as managers and carry out joint research activities. In addition, the research institutes began to accept Master's and doctoral students for internships, as well as provide scientific equipment for conducting scientific research.

Despite the measures taken, one of the weaknesses of Kazakhstani science remains low human resources potential and the aging of scientific personnel. The programme documents regulating the development of higher education and science until 2029 declare the transition of the specialist training system to a model of advanced staffing, implying the training of new generation specialists. The modern economy requires that educational institutions pay more attention to vocational education standards [1], which have an educational impact on specific industries and their human resources potential [2]. Now, the starting point for designing educational programmes is professional standards, which outline the labour functions and competencies of specialists in the specific field [3].

When determining the competence of a Master's student, the concept of readiness is often analysed from the standpoint of subjective activity and the competence component of the research activity [4].

The highly qualified specialists are in demand, specialists who are able to independently navigate the flow of changing information, who are able to compare, analyse, generalise, find the best solutions, and who have research skills to conduct research in specific areas of knowledge. Consequently, a necessary element is the readiness of future specialists to conduct research in specific areas of knowledge [5]. An important link in the process of training such specialists are Master's programmes. One of the important components in shaping the readiness of specialists for professional activities is

the development of research skills and the formation of readiness for research activities, which opens up opportunities for stimulating and growing the creative potential of an individual.

The problems of preparing Master's students for research activities, and their readiness to develop research skills, have long been a topic for discussion among research scientists from different countries. Such interest in this problem is caused by the fact that the requirements for the education system are constantly changing, and the qualification characteristics of specialists for professional activities are increasing. Today, a modern specialist must apply the acquired knowledge, skills and abilities in practice, in a society where there is constant scientific and technological progress. This defines the need for specialists to have research skills and are prepared to use them in the modern production conditions. In this case, it is necessary to take into account the personal aspect of students, which affects academic performance and motivation [6].

The area of postgraduate students' readiness for research activities includes issues of the fundamental integration, professionalisation, entrepreneurship and humanisation of their research activities [7] and issues of the academic career of Master's students [8]. The readiness of postgraduate students in terms of research skills was considered by Meerah, highlighting the following points: preliminary research, scientific work, quantitative skills, interpretive skills and report writing [9]. Carter-Veale et al identify postgraduate students' readiness to conduct research as one of the key issues when writing dissertations [10]. At the same time, a common difficulty is the use of an expanded range of analytical tools [10].

Research readiness skills, especially searching, literature review and academic writing in the field of study are necessary for Master's students to write a dissertation. At the same time, one of the requirements for research activities in postgraduate education is a publication of scientific research results [11]. Readiness can be viewed from the standpoint of the manifestation of individual personality traits and their integrity, which determine the nature of an effective individual with high productivity [12]. Research readiness skills are essential for successful completion of a Master's programme and a lifelong career [13]. A postgraduate education programme focused on developing research skills will become an incentive to solve the problems of modern production [14].

The above brief outline on the readiness development of postgraduates to conduct research leads to a conclusion about the meaning/content of this term, which can be defined as: personal education that determines the state of the learner's personality and includes a motivational and value-based attitude to this activity, a system of methodological knowledge on based on the analysis of scientific literature, and experience in carrying out research activities in various conditions.

Thus, by forming research potential within the framework of the integration of education and scientific activities, it can be possible to create a system of effective, competitive specialists both for key sectors of the economy of Kazakhstan and at the international level. The imperfection of the methodological foundations for developing the readiness of future specialists of the engineering and technical profile within the framework of postgraduate education for research activities leads to a contradiction between the socially determined need to train future specialists to effectively perform various scientific and research professional functions, and the weak theoretical and practical development of their training.

METHODOLOGY SECTION

Based on the analysed concepts of readiness, the main interconnected components of its structure are:

- motivational, characterising cognitive interest, motivation for research activities;
- orientational, including ideas about the methodology of scientific research and methods of scientific research activity;
- procedural, which determines the possession of skills and abilities for scientific research activities (Table 1).

Table 1: The main interconnected components of readiness.

Components	High	Medium	Low
Level of motivation of postgraduates for research activities			
Cognitive interest	Manifestation of controlled activity in the process of studying a specific area of knowledge.	Not in full control, but active in the process of learning activities of a specific area of knowledge, determined by internal needs, active selectively.	The orientation of the individual towards a specific field of knowledge determined by external circumstances.
Motivation for research activities	Sustained interest in research activities.	Showing interest in finding cause-and-effect relationships, studying specific areas of knowledge.	Unstable interest in individual elements of a specific field of knowledge.

Understanding the significance of research activities	Understanding the importance of research activities.	Superficial understanding of research activities.	Lack of understanding of social and personal significance; inability to see the problem.
Level of orientation of postgraduates for research activities			
Introduction to research methodology	Independently selects appropriate research methods depending on the purpose of scientific research, evaluates their effectiveness.	Chooses appropriate research methods to solve research problems under the guidance of a teacher.	Has some understanding of research.
Perception of research activities	Has clear research logic/argument skills and skills in constructing a scientific apparatus.	Formulates research goals under the guidance of a teacher, searches and processes information in accordance with them.	Has a general understanding of the goals and objectives of research.
Presentation of research activities results	Analyses the results of research activities, searches for ways to apply them in practice.	Evaluates own research activities in terms of achieved results.	Carries out little reflection on his/her research activities.
Level of procedural readiness of postgraduates for research activities			
Mastery of research logic	Masters the logic of scientific research, independently develops a research plan based on available data.	Has incomplete basic knowledge of the logic of research, builds research objectives under the guidance of a teacher.	Unable to independently build the logic of research.
Planning	Independently plans and carries out his/her own research activities in accordance with their goals.	Strictly follows the developed research schedule.	Uses ready-made plans when carrying out research activities, often in violation of the implementation schedule.
Independent research work	Independent completion of research work.	Lack of independence in performing individual sections of research work.	Constant supervision of research activities is required.
Knowledge of research methodology	Uses traditional and innovative research methods, theoretically substantiates and develops his/her own ways in methodology.	Uses the proposed methods of research methodology.	Uses intuitive research methods when performing research work as part of the curriculum.

In order to optimise the formation of engineering and technical Master's students' readiness for research activities, a pedagogical experiment was conducted at *Abylkas Saginov* Karaganda Technical University, as well as an additional scientific and educational programme (ASEP course), developed by the authors' of this article was implemented.

In this research, two types of experiments were carried out: ascertaining and formative. The experiment involved 120 graduates in engineering and technology at *Abylkas Saginov* Karaganda Technical University, Kazakhstan, (the general population was 173 students admitted to the 1st year of a Master's degree, with a confidence interval of 5). Sixty students were in the control group and the same number in the experimental group. The sampling was carried out randomly. The experiment was carried out from October 2022 to May 2023.

The choice of university was justified by its location. In the region, *Abylkas Saginov* Karaganda Technical University occupies a leading position. Karaganda is the central region of Kazakhstan and one of the leading industrial regions of the country. The share of industry in 2022 (nine months) accounted for 49.9% of the gross regional product. The volume of industrial production at the end of the year amounted to 3,841.9 billion tenges (3rd place in the Republic of Kazakhstan) [15].

The ascertaining experiment was aimed at determining the actual state of the studied object. At the stage of ascertaining the experiment, the initial level of readiness of postgraduates for research activities was determined; first-year postgraduates participated in the experiment. This choice was determined by the fact that first-year postgraduates already have basic preparation for research activities, so after graduating with a Bachelor's degree, they already have some experience in writing coursework and graduation projects.

To determine the level of readiness of first-year postgraduates for further research work, a survey was conducted in October 2022. For this purpose, a self-assessment questionnaire was used to assess their readiness for this type of activity.

This questionnaire was developed by the authors of the article based on a review of scientific literature on the formulation of the theoretical concept of *readiness*, which includes three basic elements. For prompt processing of

the collected material, the possibility of its comparative analysis, the most complete characteristics of a particular quality, the Likert scale was used.

The questionnaire includes 25 questions, divided into three blocks. The first block of questions was aimed at assessing motivation for scientific activity. The second block determined existing ideas about research work in general and specifically for each stage of research. The third block allowed to assess the level of independent work skills in conducting scientific research and its presentation. In questions aimed at diagnosing the motivational component of readiness, respondents were asked to note the most significant motives that encourage them to engage in research activities (cognitive, professional development, self-actualisation, obtaining material benefits, moral encouragement, self-realisation, social approval, achieving success, etc).

A number of questions revealed the degree to which respondents expressed interest in certain aspects of the organisation and implementation of scientific research. The questionnaire, in turn, contained a list of open-ended questions in which respondents were asked to indicate the reasons for the decrease in motivation to engage in research activities, to suggest methods of supporting and stimulating motivation to carry out scientific research, etc.

The result of the ascertaining experiment helped to determine the indicators of postgraduates' readiness for research activities. The obtained data from the ascertaining experiment represent the primary data for the formative experiment. The purpose of the formative experiment was to develop and test the effectiveness of the developed organisational and pedagogical conditions for the formation of the readiness under study. The formative experiment was carried out from October 2022 to April 2023.

The ASEP course developed by the authors of the article was used as a didactic means of conducting a formative experiment. The main goal of the ASEP is to develop readiness for independent development and implementation of scientific research within the framework of one's own Master's thesis. The implementation of the ASEP was carried out within the following components: training seminar *Research work within the framework of a Master's thesis*, and elective classes as part of a workshop on designing dissertation research. After mastering the ASEP the students were re-interviewed according to the questionnaire of the previous stage of the experiment.

RESULTS

The results of the confirmatory experiment showed that the level of training of first-year postgraduates in the control and experimental groups had a difference, which was not significant. The fixed level was not sufficient for independent implementation of scientific research activities (SRA).

The effectiveness of the implementation of the additional scientific and educational programme was confirmed by the results of a pedagogical experiment. Testing the normality of the Kolmogorov-Smirnov ($p \leq 0.2$) and Shapiro-Wilk ($p \leq 0.5$) distributions showed that the distribution differed from normal. Therefore, to compare two dependent samples in different periods, the nonparametric Wilcoxon test (T; Wilcoxon signed-rank T test) was used, which allowed to test the hypothesis that the values of the two populations from which the compared dependent samples were extracted differed from each other.

Based on the results of the analysis of Wilcoxon signed-rank tests, the number of negative ranks in the experimental group for the motivational component was significantly reduced after the experiment (average negative rank = 30.5, average positive rank = 90.5).

The following values were obtained for the motivational component of readiness (Table 2).

Table 2: The motivational component of readiness.

Statistical criteria[a]		
	M3 Control group, formative M1 Control group, ascertaining	M4 Experimental group, formative M2 Experimental group, stating
Z	-4.745[b]	-4.724[b]
Assumption (2-tailed)	0.000	0.000
a. Wilcoxon signed-rank test		
b. Based on negative ranks.		

From the above data it is clear that the value of the Wilcoxon criterion is $p \leq 0.05$; and accordingly, differences were recorded at the stage of the ascertaining and formative experiment in the experimental group in which the developed pedagogical tools were used. Despite the fact that differences also exist in the control group at the stage of the formative experiment, the number of negative ranks is higher than in the experimental group, which indicates the influence of the developed tools on the motivational components of readiness.

The following values were obtained for the operational component of readiness (Table 3).

Table 3: The operational component of readiness.

Statistical criteria[a]		
	O3 Control group, formative O1 Control group, ascertaining	O4 Experimental group, formative O2 Experimental group, stating
Z	-4.724[b]	-4.719[b]
Assumption (2-tailed)	0.000	0.000
a. Wilcoxon-signed rank test		
b. Based on negative ranks.		

The obtained value of the Wilcoxon criterion is $p \leq 0.05$, which confirms the existence of differences at the stage of the ascertaining and formative experiment in the experimental group in which the developed pedagogical tools were used.

The existence of differences in the control group, at the stage of the formative experiment, characterised by the presence of negative ranks, also indicates the presence of an influence of the developed tools on the operational component of readiness. The following values were obtained for the procedural component of readiness (Table 4).

Table 4: The procedural component of readiness.

Statistical criteria[a]		
	P3 Control group, formative P1 Control group, stating	P4 Experimental group, formative P2 Experimental group, stating
Z	-4.728[b]	-4.718[b]
Assumption (2-tailed)	0.000	0.000
a. Wilcoxon signed-rank test		
b. Based on negative ranks.		

The value of the Wilcoxon criterion for the procedural component is $p \leq 0.05$, which indicates the existence of differences at the stage of the ascertaining and formative experiment in the experimental group. In the control group, also at the stage of the formative experiment, an increased number of negative ranks is observed compared to the experimental group. Thus, the effectiveness of the developed tools for the procedural component of readiness was confirmed.

DISCUSSION

The results of the experiment showed that the developed additional scientific and educational programme is effective in developing the readiness of postgraduates in engineering and technical fields for research activities.

The introduction of such tools allows postgraduates to master research methods. The advantage of using this technique is its high adaptability for both engineering specialists and specialists in the humanities.

At the same time, the proposed methodology can be used as a mandatory component of the curriculum, or as an additional one, depending on the policy of the university.

The training seminar *Research work within the framework of a Master's thesis* at the first stage of the ASEP implementation was focused on the formation of sustainable motivation among postgraduates to organise and conduct research work within the framework of dissertation research using interactive technologies and heuristic elements based on folk tales; open discussions, presentations of completed project tasks. This technology has shown positive dynamics in the formation of the motivational component of postgraduates' readiness for research.

The workshop on designing dissertation research is focused on the formation of orientational and procedural components of readiness through the following content elements:

1) Design of the methodological apparatus of dissertation research.
2) Processing of research results.
3) Presentation of research results.

The results of the final measurements showed that postgraduates who completed the orientation component in elective classes as part of the workshop had a more detailed understanding of the research process, the logic of the study, the features and stages of research activity than students in the control group.

The results of the final measurements showed that postgraduates who completed training in the procedural component in elective classes within the practicum felt more confident when designing the methodological apparatus of dissertation research, as well as when processing and presenting the results of scientific research.

The level of readiness for research activities in the experimental group increased on average by 62% in the motivational component, 48% in the orientation component and 39% in the procedural component compared to the control group.

As a result of the ASEP implementation, it was noted that some postgraduates needed to take additional courses to develop research skills. This problem was identified for 8% of the participants in the experimental group and can be solved by developing additional educational content in an interactive mode for students' self-training.

CONCLUSION

Today, research activities of postgraduate students are an integral part of Master's studies, as they are aimed at developing research skills. This study was aimed at solving problems that arise in the process of Master's studies through the development of organisational and pedagogical conditions that ensure the formation of engineering and technical Master's students' readiness for research activities.

The obtained results of the experiment for each component based on the Wilcoxon statistical test for the compared dependent samples (at $p \leq 0.05$) indicate the effectiveness of using the developed tools for forming level readiness for the proposed components.

The achieved results allow postgraduates in the experimental group to carry out research activities within the framework of their dissertation research at a higher level than in the control group - they less often resort to the help of a supervisor, show more independence in the process of choosing a topic, research methods, setting tasks and describing the results of research activities.

REFERENCES

1. Carnoy, M., *Education, Economy and the State*. In: Cultural and Economic Reproduction in Education. Routledge, 79-126 (2017).
2. Lipset, S.M., *Values, Education, and Entrepreneurship*. Promise of Development, Routledge, 39-75 (2018).
3. Khairutdinov, R.R., Safin, R.S., Korchagin, E.A., Mukhametzyanova, F.G., Fakhrutdinova, A.V. and Nikishina, S.R., The content of educational programs in technical universities: quality of applying the modern professional standards. *Inter. J. of Instruc.*, 12, **1**, 357-370 (2019).
4. Khairutdinov, R.R., Mukhametzyanova, F.G., Fakhrutdinova, A.V., Panchenko, O.L. and Bogovarova, V.A., Forming readiness of master's degree students for scientific and research activity. *Proc. IFTE-2019*, 345-351 (2019).
5. Bloom, B.S., New views of the learner: implications for instruction and curriculum. *Educational Leadership*, 35, **7**, 563-576 (1978).
6. Maasdorp, C. and Holtzhausen, S.M., Research-readiness in postgraduate students: how do we recognise it and overcome possible deficiencies? *J. for New Generation Sciences*, 13, **2**, 44-61 (2015).
7. Miller, R.K., From the ground up: rethinking engineering education for the 21st century. *Symp. on Engng. and Liberal Educ.*. Union college, Schenectady, **3**, 19-531 (2010).
8. Johnson, T., Applications of intuitionistic fuzzy sets in the academic career of the students. *Indian J. of Science & Technol.*, 10, **34**, 1-15 (2017).
9. Meerah, T., Readiness of preparing postgraduate students in pursuit of their doctoral programme. *Procedia Social and Behavioral Sciences*, **9**, 184-188 (2010).
10. Carter-Veale, W.Y., Tull, R.G., Rutledge, J.C. and Joseph, L.N., The dissertation house model: doctoral student experiences coping and writing in a shared knowledge community. *CBE-Life Sciences Educ.*, 15, **3**, 29-34 (2016).
11. Pangket, W.F., Pangesfan, S.K.K., Cayabas J.P. and Madjaco, G.L., Research writing readiness of graduate students in a Philippine state college. *Inter. J. of Learning Teaching and Educational Research*, 22, **4**, 141-159 (2023).
12. Asafova, E.V. and Vashetina, O.V., Readiness for professional and pedagogical self-development: results dynamics among students of master's programs in pedagogy. *Systematic Reviews in Pharmacy*, 11, **12**, 1450-1455 (2020).
13. Ivanitskaya, L., Laus, R. and Casey, A.M., Research readiness self-assessment: assessing students' research skills and attitudes. *J. of Library Administration*, 41, **1-2**, 167-183 (2004).
14. Sidhu, G.K., Yean, F.Y., Choo, L.P., Nawi, S.M., Kannan, S. and Shamida, A., Postgraduate students' self-perceived readiness to graduate on time. *Review of Inter. Geographical Educ.*, 11, **11**, 303-315 (2021).
15. QAZALEM: Karaganda Region, 25 October 2022, https://www.gov.kz/memleket/entities/qazalem/activities/27975?lang=en