Mathematical statistics in the professional activity of future engineers Bachelor's degree programs Technosphere security

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Abstract. For the successful implementation of professional activity, a young specialist must have a certain set of competencies that characterize him as a professional, allowing him to navigate in his profession, to be competitive in the labor market. In this regard, we decided to consider the formation of professional competencies through the tasks of applied significance, namely, through the tasks of mathematical statistics. The formation of professional competencies is one of the priority tasks of optimizing the educational process, which improves the process of forming knowledge, skills and abilities, activates mental and cognitive activity, as well as the level of knowledge.

1 Introduction

All the changes in the field of education that are taking place in the world, including in Russia, can be compared with the global task of implementing a system for the development of key competencies that determine the modern quality of education. The XXI century is a century of rapid development of information technologies. Within the framework of the Concept of Modernization of Education in the Russian Federation for the period up to 2025, new requirements for professional competencies of specialists are emerging, allowing them to quickly adapt to dynamic changes, critically comprehend the data obtained and master new types of production activities. The introduction of digitalization, the development of new information technologies, taking into account universal knowledge and key competencies, leads to a rethinking of the concepts and set of requirements for an employee as an effective and competitive specialist. In the context of economic instability, the question arises about the increasing need to acquire the skills of key competencies and qualifications of employees. Therefore, the competence approach in the system of higher professional education is a priority in the preparation and improvement of human resources [1].

From the point of view of the competence approach, the level of education is determined by the ability to solve problems of various levels of complexity based on

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existing knowledge. The competence approach focuses on the ability to use the acquired knowledge.

The analysis of the psychological and pedagogical literature shows that there are different approaches to the interpretation of the concept of competence, competence, competence approach, but there is no single view on this definition.

So in his works, Ermakov D. S. defines the competence approach as a method of modeling the goals and results of education as the norms of its quality, the reflection of the result of education in a holistic form as a system of signs of the graduate's readiness to carry out a particular activity [2].

From the point of view of Troyanskaya S. L., the competence approach is a priority orientation of education on its results: the formation of the necessary general cultural and professional competencies, self-determination, socialization, development of individuality and self-actualization [3].

In our opinion, the competence approach is the formation and development of a set of necessary key and professional competencies that determine successful adaptation in society. Key competencies enable the development of such personal qualities as purposefulness, independence, sociability, intellectual self-improvement, initiative. The process of forming professional competencies begins with the student's admission to Higher education, and continues throughout the entire stage of his professional activity.

In the system of higher education, the concept of competence acts as the main concept of the content of education. In addition, the formation of competencies that determine the quality of education is the main task of higher education, within the framework of the FSES VO 3++, taking into account professional standards. To get a competent specialist focused in all potentially significant areas, it is necessary to apply active and interactive teaching methods, to develop the student's cognitive, communicative and personal activity.

According to the content of education within the framework of the Federal State Educational Standard of Higher Education, in addition to key, professional, general professional competencies, there are also interdisciplinary competencies that form the ability and willingness of a student to apply the acquired knowledge in professional activities, their transformation into "knowledge in action" [4]

The formation of competence based on the principle of interdisciplinarity solves the contradiction between the disparate assimilation of knowledge and the need for their integration, integrated application in practice, professional and social activities of a person. The theoretical approach to any activity in modern conditions is based on the ability to comprehensively apply knowledge, synthesize it and transfer ideas and methods from one science to another. The training of such knowledge and skills is dictated by the trends of integration into science and practice and is solved through interdisciplinary connections.

For a subject teacher, the formation of interdisciplinary competencies is one of the priority tasks in optimizing the educational process, with the help of which the process of forming knowledge, skills and abilities is improved, mental and cognitive activity is activated, and the level of professional qualification of a specialist is increased. For the successful implementation of professional activity, a young specialist must have a certain set of competencies that characterize him as a person and a professional, and allow him to navigate in his profession, be competitive in the labor market, and be ready for self-education [5].

An important tool of the applied orientation of teaching mathematics is interdisciplinary competencies, which help to form integrated knowledge, skills, and skills for solving non-standard problems of an applied nature using mathematical apparatus, the development of imaginative and logical thinking.

The analysis of the psychological and pedagogical literature showed that such authors of scientific works as Malchukova N. N. Kulikova S. V., Yakobyuk L. I., Biryukova N. V.

E.A. Semizorov, and many others were engaged in the implementation of interdisciplinary competence through the solution of mathematical problems of an applied nature [6-14].

So according to Malchukova N. N., Shemyakina I. E., the implementation of interdisciplinary competence can be carried out in various ways. One of the more effective ways to achieve this goal is to solve applied problems from related disciplines, which allow students to show the use of mathematical methods to solve problems from other subject areas [15].

In the process of professional training of students, the role of the formation of interdisciplinary competence is increasing and is currently relevant in the process of studying mathematics and related disciplines.

2 Research methodology

The formation of interdisciplinary competencies contributes to the transition from the separate teaching of different subjects to their deep interaction. The acquired interdisciplinary skills will be useful for a young specialist when performing practical tasks of the final certification, since the results of the development of the state general education program of higher education are determined by his ability to apply knowledge, skills, and skills in accordance with the tasks of professional activity. Graduates who have mastered the bachelor's degree program in the direction of training 20.03.01 Technosphere Safety can carry out professional activities in the field of professional prevention, fire prevention and extinguishing, labor protection, construction and housing and communal services, etc.

In accordance with the Federal State Educational Standard of Higher Education, the discipline mathematics belongs to the basic part of the first block of the curriculum of the training direction 20.03.01 "Technosphere security", and is a special discipline, since the knowledge obtained in the study of mathematics is fundamental knowledge. The section of the discipline Mathematical Statistics is studied in the second year of the fourth semester in the amount of 144 academic hours. Second-year students participated in the experiment.

The formation of interdisciplinary competence through mathematical problems of an applied nature among students studying in this direction was implemented in the course of a pedagogical experiment conducted based on the Federal State Educational Institution of Higher Education of the Northern Trans-Urals in 2020-2021 in the number of 50 people. The experiment was conducted during lectures and practical classes in mathematics throughout the entire period of studying the section Mathematical statistics. The experimental and control groups were identified. Classes with control groups were conducted based on traditional methods, using non-applied tasks. Methodological foundations research is a set of general and special scientific methods of cognition. The research is based on the methods of comparison, generalization of the content of concepts and categories, which made it possible to conduct a comparative analysis of learning outcomes, qualitative and quantitative analysis of the data obtained.

3 Research results

In the course of studying the section Mathematical statistics, the subject content of the discipline for experimental groups included problems of an applied nature. The main idea of the experiment is to demonstrate the connection of mathematics with the chosen profession. Tasks developed within the framework of a professional orientation, develop interdisciplinary competencies and a positive attitude to the study of the subject. The results of the experiment were summed up by evaluating the assimilation of the studied material on

the main issues of the discipline section in the form of testing. The developed test tasks for the experimental and control groups were the same.

Let us consider an example-a mathematical application value problem that form interdisciplinary competencies by means of the mathematical apparatus.

For 22 districts of the Tyumen region, there are data on the population and the number of fires for January-February 2021 (data are shown in table 1). Assuming that there is a linear correlation between the variables X and Y:

a) Make a correlation table, and find the equations of the dependence of the population (Y) and the number of fires (X).

b) Calculate the correlation coefficient at the significance level of 0.05, evaluate its significance and conclude about the closeness and direction of the relationship between the variables X and Y.

Table 1. Data on the population and the number of fires in the districts of the Tyumen region

№	Name of the district	Population (thousand people) Y	Number of fires X
1.	Armizonsky	9,1	4
2.	Abatsky	16,5	9
3.	Aromashevsky	10,1	5
4.	Berdyuzhsky	10,6	9
5.	Vagaysky	20,4	6
6.	Vikulovsky	15,1	6
7.	Golyshmanovsky	25,1	13
8.	Zavodoukovsky	46,8	17
9.	Isetsky	24,9	9
10.	Ishimsky	93,0	25
11.	Kazansky	21,2	8
12.	Nizhnetavdinsky	21,7	16
13.	Omutinsky	18,1	8
14.	Sladkovsky	10,0	6
15.	Sorokinsky	9,4	2
16.	Tobolsky	20,3	12
17.	Tyumensky	127,3	62
18.	Uvatsky	19,3	7
19.	Uporovsky	20,3	6
20.	Yurginsky	11,2	5
21.	Yalutorovsky	54,3	19
22.	Yarkovsky	23,0	7

Solving this problem, the students faced the question of compiling a correlation table, the result of which is shown in Tabl 2:

To draw up an equation for the dependence of the population (Y) and the number of fires (X), the following indicators were calculated:

$$\bar{x} = \frac{\sum x_i n_x}{n} = \frac{261}{22} = 11,86;\ \overline{x^2} = \frac{\sum x_i^2 n_x}{n} = \frac{6371}{22} = 289,6;\ \sigma_x = \sqrt{\overline{x^2} - \overline{(x)^2}} = 28,47;$$

$$\bar{y} = \frac{\sum y_i n_x}{n} = \frac{627,7}{22} = 28,53;\ \overline{y^2} = \frac{\sum y_i^2 n_x}{n} = \frac{35744,05}{22} = 1624,73;\ \sigma_y = \sqrt{\overline{y^2} - \overline{(y)^2}} = 12,2;$$

$$\overline{xy} = \frac{\sum x_i y_i n_x}{n} = \frac{14584,11}{22} = 662,91; \quad \bar{r} = \frac{\overline{xy} - \bar{x} \cdot \bar{y}}{\sigma_x \cdot \sigma_y} = 0,93;$$

$$y_x - \bar{y} = r \frac{\sigma_x}{\sigma_y}(x - \bar{x}); \; y_x = 0,4x + 23,76$$

Table 2. Correlation table of the dependence of the population and the number of fires

Y X	**2**	**4**	**5**	**6**	**7**	**8**	**9**	**12**	**13**	**16**	**17**	**19**	**25**	**62**	n_y
9,1		1													1
9,4	1														1
10,0				1											1
10,1			1												1
10,6							1								1
11,2			1												1
15,1				1											1
16,5							1								1
18,1						1									1
19,3					1										1
20,3				1				1							2
20,4				1											1
21,2						1									1
21,7										1					1
23,0					1										1
25,1									1						1
24,9							1								1
46,8											1				1
54,3												1			1
93,0													1		1
127,3														1	1
n_x	1	1	2	4	2	2	3	1	1	1	1	1	1	1	22

Thus, since the correlation coefficient is positive, it can be concluded that the relationship between the considered features is direct, i.e. the population size depends on the number of fires in the southern region of the Tyumen region, since the coefficient is 0.93, which indicates that the linear relationship between the considered features is very high.

It becomes necessary to test the hypothesis about the significance of the correlation coefficient, i.e., whether it differs significantly from zero in the general population.

Let be $H_0 : r_g = 0; H_1 : r_g \neq 0.$

Using the Student's t-test, we find:

$$t_{obser} = \frac{r}{\sqrt{1-r^2}}\sqrt{n-2} = 12,1; \qquad t_{cricial} = t(\alpha; k) = t(0,05; 20) = 31,4.$$

Thus, $t_{obser} < t_{cricial}$ we accept the main hypothesis, and we consider the general correlation coefficient to be insignificant, therefore, there is no connection between the considered features, i.e. the number of fires in a particular area is not affected by the population size.

Because of the experiment, the final testing was carried out, the results of which are shown in Figure 1.

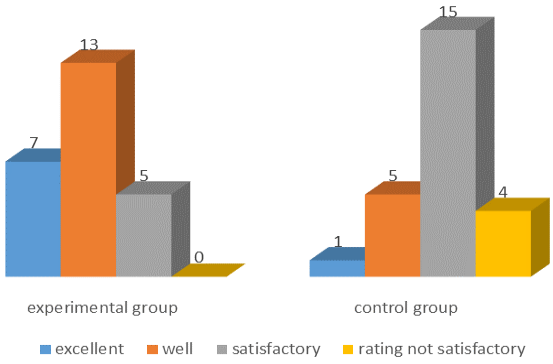

Fig. 1. Results of the experiment

Analysis of the data obtained during the diagnosis of the experiment showed a significant improvement in indicators in the experimental group compared to the control group. The average score received by the students in the control group was 3.12, and in the experimental group, it was 4.08. This made it possible to draw a conclusion about the varying degrees of development of practical skills in the application of practical tasks in the study of the section of mathematical statistics in the experimental and control groups. Consequently, it can be stated that mathematical competence increases due to the activation of cognitive interest in the study of mathematics by understanding the significance of the subject material in practice [14].

4 Conclusion

Thus, in order for the mathematical training of engineering students to be effective, it is necessary to include professional tasks containing special terms of engineering science, thereby increasing interest in the subject being studied.

In the process of teaching students, it is necessary to actively use innovative teaching methods, since their application solves a number of important tasks: makes classes more visual, attracts passive students to active activities; allows you to organize self-control in the pro; increases motivation for classes, activates the cognitive interest of students and contributes to the implementation of a personality-oriented and differentiated approach to learning, as well as builds individual learning trajectories, which largely leads to an increase in the effectiveness of education.

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