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The research activity of the Bachelor Students

La actividad de investigación de los estudiantes universitarios

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ABSTRACT:

The transition of higher education establishments to a Bachelor-Masters system requires teachers to take a deeper, more systematic study of the issues of ensuring the professional qualities of graduates, in particular, in the direction of training “Pedagogical Education”. One of the actual directions of development of the educational process of the higher educational establishment is the formation of students' readiness for research and development.
Keywords: higher education, teacher education, research activities of students, mathematical preparation, game theory

RESUMEN:

La transición de los establecimientos de educación superior a un sistema de Bachelor-Masters requiere que los profesores realicen un estudio más profundo y sistemático de las cuestiones de garantizar las cualidades profesionales de los graduados, en particular, en la dirección de la formación "Educación Pedagógica". Una de las direcciones reales de desarrollo del proceso educativo del establecimiento de educación superior es la formación de la preparación de los estudiantes para la investigación y el desarrollo.
Palabras clave: educación superior, educación de docentes, actividades de investigación de estudiantes, preparación matemática, teoría de juegos

1. Introduction

The impact of huge information flows, the rapid development of technology and technology lead to changes in the school system, as a consequence, to changes in the training of future teachers.

The analysis of the federal state educational standard of higher education in the direction of “Pedagogical education” (the profiles “Mathematics” and “Physics”, “Mathematics” and “Informatics”) and the composition of general cultural, professional and special competencies allows us to conclude that the model is based on the model specialist, focused on self-development. Thus, for example, the future teacher should have the ability to self-organize and self-education (OK-6); the ability to use the capabilities of the educational

environment to achieve personal, meta-subject and objective learning outcomes and ensure the quality of the teaching and educational process by means of the taught subject (KC-4); ability to organize cooperation of students, to support activity and initiative, independence of students, develop their creative abilities (KC-7); readiness to use systematized theoretical and practical tasks for setting and solving research problems in the field of education (KC-11); the ability to manage the teaching and research activities of students (KC-12); the culture of mathematical thinking, the ability to understand the general structure of mathematical knowledge, the relationship between various mathematical disciplines, to realize the basic methods of mathematical reasoning on the basis of general methods of scientific research and the experience of solving academic and scientific problems, to use the language of mathematics, correctly express and reasonably justify the available knowledge (AK- 2) and others.

Obviously, the formation of these competencies is not possible without the research skills. The scientific literature has many interpretations of the concept of "research activities of students". The authors agree with the definition by M.I. Koldina: "This type of activity is a kind of creative, cognitive activity aimed at mastering students by independent theoretical and experimental work, modern methods of scientific research, experimental techniques" (Koldina, 2009). Experience in the management of research activities of students shows that systemic studies of such work are effective. Thus, it is very important to formulate students' readiness to engage in the research work. Voistinova, Solochchenko (2014), Vorobyev, Fomina (2017), Koldina (2009) distinguish the following as problems of research work of students:

- Activization of cognitive activity of students;
- In-depth creative mastering of the specialty;
- Gaining the skills of research and design work;
- Formation of information and communication skills.

Research activities of students in teaching mathematics are powerful factors in activating their cognitive activities if it includes not only the solution of educational research tasks in the study of mathematical disciplines but also full participation in research work. In this connection, the authors set the following tasks:

- Generalization of the experience in the management of students' research activities in the process of teaching mathematics;

- Identification of the main directions of the project activities of students in the areas of "Pedagogical Education" and "Vocational Training";

- Analysis of the basic component of the project activity in the school and the system of additional education;

- Determination of the priorities of research projects by means of game theory.

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2. Literature review

Despite the fact that the Bachelor's degree is receiving general education and general professional training, there is a need and the possibility of continuous development of the research competence of students during their studies on the basis of mastering, first of all, research competence.

Various aspects of research activities of students are studied in the works of many domestic and foreign scientists and teachers. Thus, for example, the general issues of scientific research are discussed in the works by G.M. Lokhonova (2010), S.N. Lukashenko (2012), and others, the organization of research work of students is considered in the works by E.V. Berezhnova (2007), V.V. Krayevsky (2001), E.A. Shashenkova (2010), and others. Research procedures are disclosed by V.I. Zagvyazinsky (2008). The organization of management of the research process was considered in the works of Yu.K. Babansky (1982), M.M. Potashnik (1991), P.I. Pidkasisty (2005), and others. Models of forming scientific research activity skills in students of the pedagogical college are proposed by S.N. Lukashenko (2012) and others. Analysis of innovative educational technology "Research activities of students" was carried out by A.V. Leontovich (2003), L.F. Fomina (2008) and others.

However, the analysis of indicators of the effectiveness of the influence of research work of students on the preparation of future teachers shows that this problem needs further study and identification of continuity in the organization of research work in the higher educational establishment and school. This determines the relevance of the study.

Within the framework of this article, extracurricular research work is considered, namely, participation in scientific and practical conferences and the implementation of research projects.

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3. Materials and methods

In carrying out this study, the authors used the following methods: theoretical analysis of materials on the problem, documents on the organization of research work of students: formation of a database of pedagogical experience in the field of organization of research activities of students and the generalization of the received material, questioning; modeling, analysis of the experience of school teachers on organizing the research activity, methods of game theory.

3.1. The research activities of students studying in the field of training “Pedagogical Education” (“Mathematics” and “Physics”, “Mathematics” and “Informatics”)

The research activities of students should be regarded as a system, its content cannot be arbitrarily invented. Actual in educational systems is the implementation of the principle of dynamic balance, which manifests itself in the desire to achieve a harmonious state. The following functional components of the educational system are singled out (Kuzmina & Sofyino, 2012):

- Gnostic (includes actions related to the accumulation of new knowledge, and the ability to acquire new competencies from one's activities and mastering new information);

- Design (includes activities related to the long-term planning of tasks and their solutions in future professional activities);

- Constructive (includes actions for the selection and compositional construction of information, determining the characteristics of the forthcoming activities);

- Communicative (includes actions related to the establishment of pedagogically appropriate relationships between all participants of the educational process);

- Organizational (includes actions to implement pedagogical ideas in the direction of achieving the desired pedagogical result).

There must be a certain balance between these components, which is characterized by:

- Optimization of the system components;

- The possibilities of their change under the influence of the information and educational environment (IEE);

- The tendency of the system to be in optimal balance due to both traditional and new methodical techniques.

The pedagogical higher educational establishment has two directions of scientific research activity of students:

- Activities within the framework of the curriculum (study and research assignments, abstracts, reports, term papers, final qualification papers);

- Activities not included in the training programs (participation in the work of circles, scientific and practical conferences, Olympiads in subjects, development of research projects).

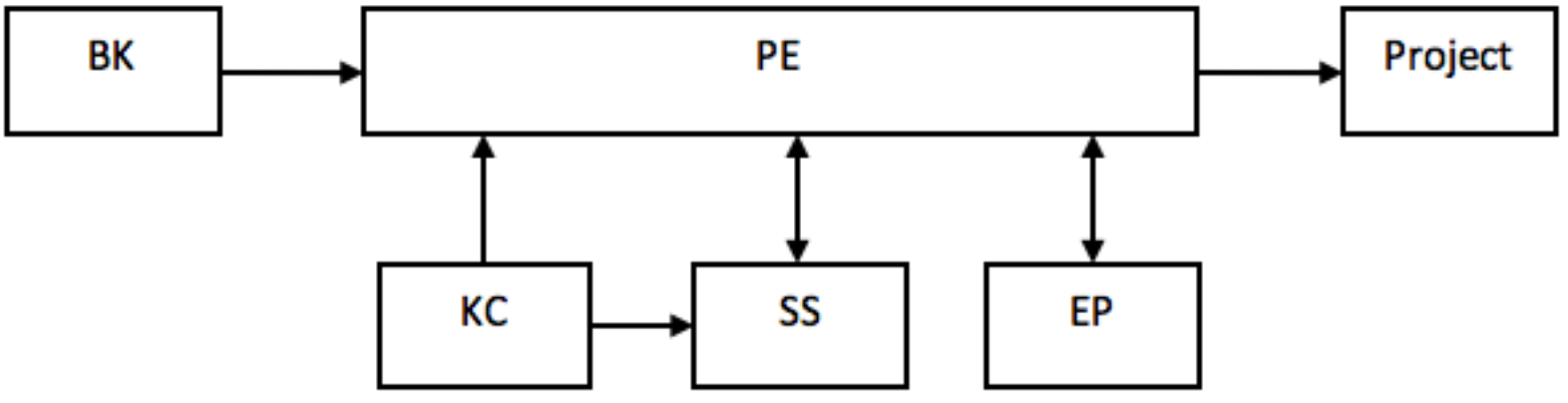
Research activities in the curriculum are carried out by students during school hours and designed to instill in students the skills of independent study of disciplines, work with scientific and educational literature, and work in a team.

The research work of students during extra-curricular time is a higher level of activity: promotes the formation of research and professional skills (work with literature, carry out a comparative analysis of the material, draw conclusions and generalizations of an interdisciplinary nature, apply mathematical knowledge to solve various problems, etc.). This type of activity not only ensures good assimilation of the studied material but also stimulates the student's cognitive activity (Bordovskaya et al., 2017).

Let us consider one of the forms of scientific research activity - participation in scientific and practical conferences and, accordingly, the development of the research projects.

The authors believe that the enlarged student's project activity can be depicted in the form of a diagram depicted in Figure 1.

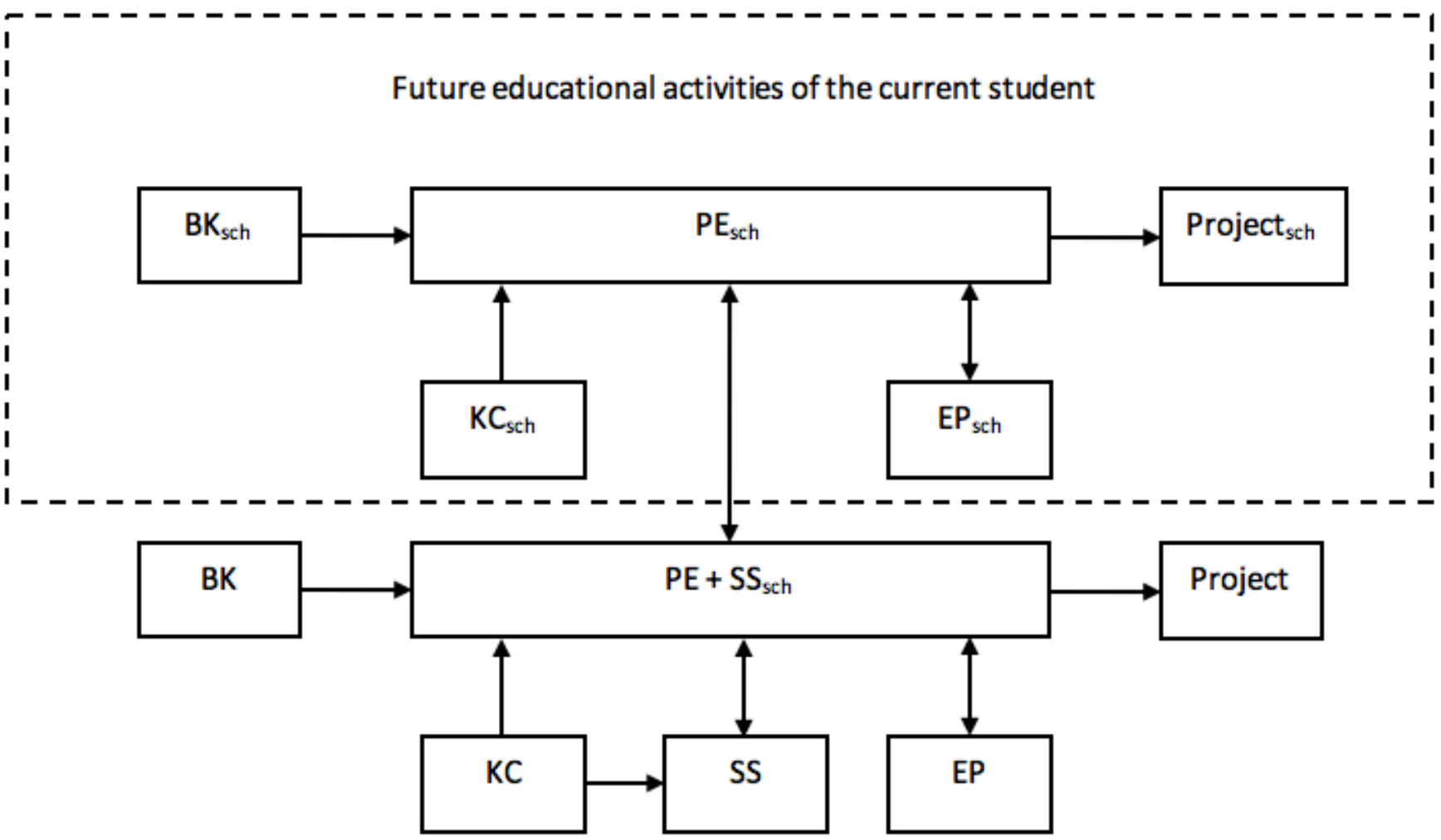
Figure 1
Simplified scheme of student's project activity



Where: PE - the project executor, work on the project; SS - the scientific supervisor(s), scientific advisers; BK - the basic knowledge and competencies available to the project implementer prior to commencing work on the project; KC - knowledge and competencies acquired by the executor (scientific supervisor) in the process of working on the project; EP - the experimental part of the project.

The scientific supervisor(s), scientific advisers act as a management system, and the executor of the project, work on the project, are the objects of management. There are two links between the control system and the control object: direct (control) and reverse (the impact of the project's executor or their work, on project managers). In addition, there are links to the external environment: Basic knowledge and competencies available to the project implementer prior to the commencement of work on the project; knowledge and competence acquired by the executor (and his supervisor) in the process of working on the project.

Figure 2
Simplified scheme of student's project activity and the pedagogical areas



Let us call the scheme shown in Figure 1, a two-link (links: scientific supervisor and executor of the project). For the students of “Pedagogical Education” and “Vocational Training”, the above scheme, in our opinion, taking into account a somewhat remote perspective, can be transformed into a three-link scheme, shown in Figure 2.

In the above scheme, the student's research work is projected onto the future professional activity. In the analyzed scheme, the index “sch” indicates school design activity (or project activity in the system of additional education). The student (EP - the executor of the project) in the long term already is the scientific head of the project activity of schoolchildren (SS sch).

The hypothesis of this research is that the project activity of the school teacher, especially in the first years of work, is based, first of all, on student research work. The conceptual-target component of the model includes the idea of forming the future teacher's competencies aimed at managing the project activities of schoolchildren, through the implementation of works on similar subjects in the student years. The authors suggest an emphasis in the research work of bachelors of the direction “Pedagogical Education” on the applied direction of research and consideration of regional features. Achieving the desired result can be accomplished by gradual climbing of students on individual development trajectories.

The natural result of the research activities of students is participation in the work of scientific-methodological and scientific-practical conferences. Such conferences presuppose not only the preparation of theoretical reports, but also active discussion by students of possible solutions to practical, methodological, and experimental problems. A speech before a large audience of listeners contributes to the improvement of oratory skills, which is not unimportant for the future teacher. And the number of students participating in conferences is increasing every year. Thus, n 2010, there were 7 such students of the third course of the “Mathematics” and “Physics”, “Mathematics” and “Informatics” professions, which amounted to 17.5%; in 2012 - 22, and this is 55%, and in 2017, 28 students (70%) participated in the conferences.

3.2. The research work of the student, as the basis of the project activity in the school

The authors believe that such applied mathematical disciplines as “Probability Theory and Mathematical Statistics”, “Discrete Mathematics”, “Mathematical Modeling”, “Game Theory”,

"Operations Research", "Optimization Methods", and some and other disciplines having a practical focus, provide great opportunities for fruitful research work.

Mathematics provides great opportunities for the development of creative abilities, spatial imagination, and all types of thinking of students. The importance of mathematics as an instrumental basis of fundamental and applied research is constantly increasing in modern conditions.

Participation of students in scientific conferences forms the responsibility for the performance of theoretical and practical research. Thus, the student has the opportunity to compare his work with others, highlight the weak and strong points of the research, and draw conclusions.

The proposed technology for the design of the content of research work includes the following stages:

1) The level of student readiness to participate in research activities is determined;

2) The subjects of research projects are prepared based on the specific objectives;

3) The content modules of the problem are compiled based on the selected topic;

4) The degree of independence and the choice of the type of activity is determined in accordance with each content module: search or reproductive;

5) The methods and means of project implementation are highlighted.

Our students deliver reports during the annual scientific conference, school of young scientists "Actual problems of natural sciences and their teaching", Lomonosov readings of students and schoolchildren, conducted on the basis of the LSPU. Also, some students take part in the work of All-Russian scientific-methodical and scientific-practical conferences: "Digital educational resources in the educational process of a pedagogical higher educational establishment and school" (Voronezh, VSPU, 2007, 2008), "Innovations and Information Technologies in Education" (Lipetsk, LSPU, 2009-2014), Inter-university Student Scientific and Practical Conference "The formation and development of the information society: Theory, Concept, Problem" (Lipetsk, LSPU, 2013-2015), International Scientific and Practical Conference" Modern Society, Education, and Science" (Tambov, TSU, 2014-2016), "Actual problems of natural sciences and techniques their teaching" (Lipetsk, LSPU, 2011-2017), etc.

Carrying out such work, students learn to reason, prove, transfer the acquired knowledge to a new situation, simulate, process statistical data, etc. Scientific research work of bachelors of the direction of preparation "Pedagogical education" contributes not only to raise the level of their preparation and development of creative abilities but also is the basis of their future professional activity. Especially the competence level in organizing the project activity of schoolchildren.

Thus, the authors offer the following topics of the projects: Various interpretations of the basic concepts of the probability-statistical line; Solving problems using combinatorial schemes without repetition; Solving problems using combinatorial schemes with repetitions; Methods for solving combinatorial problems from the Unified State Exams; Methods of solving the Olympiad combinatorial problems; Evaluation of the impact of various forms of learning on the assimilation of material through correlation analysis; Evaluation of the influence of various forms of knowledge control on the assimilation of the material of the discipline by the method of correlation analysis; Probabilistic methods for evaluating the effectiveness of innovation projects; Game models of cooperation, etc.

Among the teachers of the schools of the Lipetsk region, students of advanced training courses and participants of various scientific and methodical conferences, a survey was conducted on the basic component of their project activities in the school and the system of additional education. 150 teachers participated in the survey, 30 of them indicated that they do not engage in design work or are engaged in an insignificant measure. The results of the answers of the rest of the questionnaire to the question "What is the main basis of your project activity with students?" (It was suggested to estimate the percentage of the role of this or that component):

- Basic knowledge and competencies obtained at the higher educational establishment - 15%;

- Knowledge and competencies obtained in the process of performing scientific research in the higher educational establishment - 45%;

- Knowledge and competencies acquired in the process of analysis of scientific and methodological literature - 13%;

- Ideas received from participation in scientific-methodical and scientific-practical conferences, seminars, etc. - 10%;

- Personal experience of teaching activities - 5%;

- Subjects of projects offered by students and their parents - 10%;

- Another basis for the project activity - 2%.

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4. Results and discussion

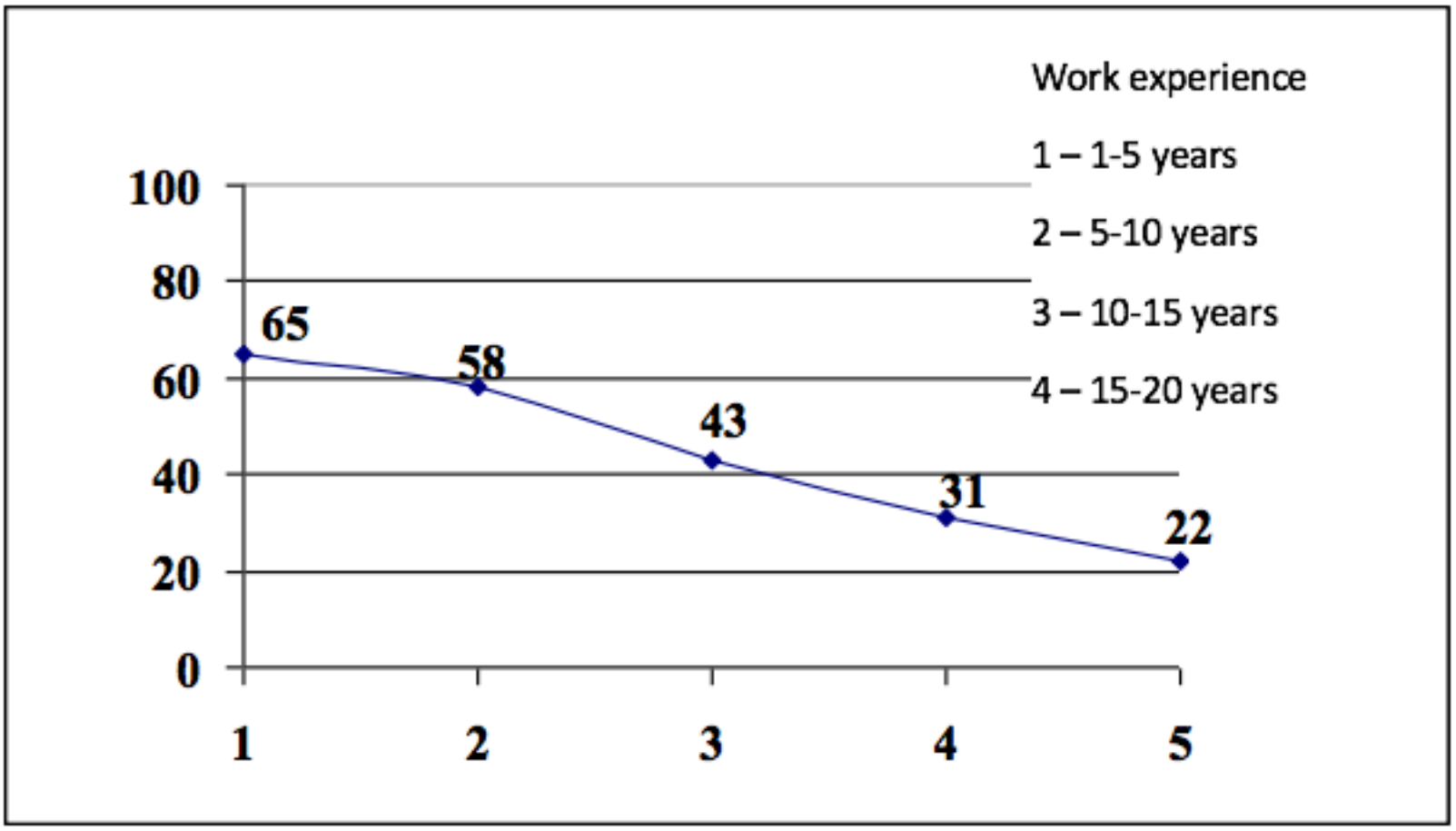
The interest in scientific work, research skills, ability to solve professional problems arising in the process of research independently, creative abilities, skills of working with special and scientific literature all contribute to the professional growth of students, increases the level of competence in the chosen profession, which makes them in demand on the market labor.

In order to determine students' readiness for research and development activities, questionnaires were conducted for students in the field of training “Pedagogical Education”, profiles “Mathematics” and “Physics” and “Mathematics” and “Informatics”. The results of the questionnaire showed that 82% of respondents experience significant difficulties in organizing research activities; 80% of the students surveyed believe that a higher educational establishment does not enough conditions to stimulate motivation to engage in research activities; 76% of students (in own opinion) have a low level of readiness for research, 16% - medium and only 8% - high.

When analyzing the role of knowledge and competencies obtained in the process of performing research work in a higher educational establishment for organizing the project activity of schoolchildren, depending on the length of the teacher's work (the teacher of additional education), then this component is prioritized for young teachers. Figure 3 shows the influence of knowledge and competencies obtained in the process of performing research work in a higher educational establishment, on the design work in the school, depending on the length of service of the teacher (the teacher of additional education). The role of this component in the organization of project activities of schoolchildren was assessed in percent.

Figure 3

The influence of knowledge and competencies obtained in the process of performing research work in a higher educational establishment, on the design work in the school



It is clear that the project activity of the school teacher, especially in the first years of work, is based, first of all, on student research work. The conceptual-target component of the model includes the idea of forming the future teacher's competencies aimed at managing the project activities of schoolchildren, through the implementation of works on similar subjects in the student years.

In the course of the research, some areas of research projects were analyzed (actual problems of mathematics, computer science, and physics, methodological aspects of the school course of mathematics, computer science and physics, the use of information and communication technologies in teaching, inter-subject communications) of students on the six factors: time costs, the attractiveness of the topic, the importance for future professional activity, the use of a mathematical apparatus, the availability of a creative element, and the achievement of the qualification requirements level. An eleven-point rating scale was chosen for the analyzed decision-making situation under uncertainty. Considering experts' scores, the effectiveness of using each direction was described by the following matrix:

$$A = \begin{Vmatrix} 4 & 2 & 8 & 5 & 3 & 5 \\ 2 & 3 & 5 & 11 & 4 & 4 \\ 8 & 5 & 3 & 10 & 4 & 6 \\ 1 & 4 & 2 & 8 & 9 & 9 \end{Vmatrix}.$$

Let us find the values of the criteria for the selection of the optimal direction of projects:

1) The maximax criterion. Select the maximum value of 11 from the maxima for each row of the matrix {8; eleven; 10; 9}. Hence, this criterion recommends the second strategy.

2) The Wald criterion. Let us take a maximum of the smallest line values, it is equal to 3. This criterion recommends the third strategy.

3) The Savage criterion. Let us build the risks matrix

$$R=\begin{pmatrix} 8-4 & 5-2 & 8-8 & 11-5 & 9-3 & 9-5 \\ 8-2 & 5-3 & 8-5 & 11-11 & 9-4 & 9-4 \\ 8-8 & 5-5 & 8-3 & 11-10 & 9-4 & 9-6 \\ 8-1 & 5-4 & 8-2 & 11-8 & 9-9 & 9-9 \end{pmatrix} = \begin{Vmatrix} 4 & 3 & 0 & 6 & 6 & 4 \\ 6 & 2 & 3 & 0 & 5 & 5 \\ 0 & 0 & 5 & 1 & 5 & 3 \\ 7 & 1 & 6 & 3 & 0 & 0 \end{Vmatrix}.$$

According to the Savage criterion, the DM tries to choose an action in which the risk value takes the least value in the most unfavorable situation, i.e. $W = \min_i \max_j r_{ij}$. The minimum of the largest line values is 5. This criterion recommends the third strategy.

4) The Hurwitz criterion. Let us calculate $\max_{1 \le i \le m} [\alpha \min_{1 \le j \le n} aij + (1-\alpha) \max_{1 \le j \le n} aij]$ at $\alpha = 0,6$:
$\{0,6 \cdot 2 + 0,4 \cdot 8; 0,6 \cdot 2 + 0,4 \cdot 11; 0,6 \cdot 3 + 0,4 \cdot 10; 0,6 \cdot 1 + 0,4 \cdot 9\} = \{4,4; 5,6; 5,8; 4,2\}$.
The Hurwitz criterion also recommends the third strategy.

5) The Laplace criterion. Let us assume that the probabilities of states of nature are equal, i.e. $q_j = 1/6$. The solution is determined from the condition $\max_{1 \le i \le m} (\frac{1}{n} \sum_{j=1}^{n} a_{ij})$:

$\frac{1}{6}(4+2+8+5+3+5) = 4,5$; $\frac{1}{6}(2+3+5+11+4+4) = 4,83$;

$\frac{1}{6}(8+5+3+10+4+6) = 6$; $\frac{1}{6}(1+4+2+8+9+9) = 5,5$.

The greatest value is achieved on the third strategy.

Analyzing the received decisions, the authors came to the conclusion about the necessity to recommend to students the applied research direction, in particular, "The use of information and communication technologies in teaching". Also, the authors believe, some emphasis is placed on subject areas related to the characteristics of the region and the higher educational establishment.

5. Conclusion

The developed technology of involving students in research work implements the gradual ascent of students on individual development trajectories. It is on this path (the mastery of knowledge in the process of creating its own educational product) that creative self-realization, self-improvement, self-development of the individual occur, and the mathematical, communicative and professional competencies of future specialists are formed and developed.

Concluding the discussion of the problem of involving students in the implementation of research work, it can be noted that its effective solution is possible only with the joint efforts of students and teachers. The gain is mutual: the student acquires the necessary professional competencies (independence of judgments, ability to concentrate, constantly self-educating, just to be able to work purposefully and thoughtfully) and the teacher (after all, the best gain is a truly educated, comprehensively developed person who will always remember the lessons learned in student years).

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