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FORMATION OF RESEARCH COMPETENCE OF STUDENTS AT THE PROCESS OF STUDYING THE VISCOSITY OF A LIQUID

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Abstract

The article examines the goals and objectives of the methodology for forming the research competence of students, using the example of the study of the internal viscosity coefficient of a liquid. The results of the study allowed us to establish components of subject research competence and find out its main structural elements - the readiness, ability of students to perform educational research, following the stages of organizing research activities, which are based on the logic of implementation of a research project. The practical implementation of the formation of this competence is one of the topical issues of educational practice of the pedagogical University, since its results deepen, expand and specify modern ideas about the information and communication capabilities of cognitive activity of students.

Keywords: research competence, student, education, educational research, viscosity, fluid.

Аннотация

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ФОРМИРОВАНИЕ ИССЛЕДОВАТЕЛЬСКОЙ КОМПЕТЕНТНОСТИ СТУДЕНТОВ В ПРОЦЕССЕ ИЗУЧЕНИЯ ВЯЗКОСТИ ЖИДКОСТИ

В статье изучены цели и задачи методики формирования исследовательской компетенции обучающихся, на примере исследования коэффициента внутренней вязкости жидкости. Результаты исследования позволили установить компоненты предметной исследовательской компетенции и выяснить ее основные структурные элементы - готовность и способность обучающихся выполнить учебное исследование, следуя этапам организации исследовательской деятельности, которые базируются на логике выполнения научно-исследовательского проекта. Авторы раскрывают основные составляющие данного понятия, которое связано с личностным образованием будущих специалистов, обладающих широким кругозором, специальными компетенциями и рациональным стилем информационной и коммуникационной деятельности. Практическая реализация формирования данной компетентности представляет собой один из актуальных вопросов образовательной практики педвуза, поскольку ее результаты углубляют, расширяют и конкретизируют современные представления об информационных и коммуникационных возможностях познавательной деятельности студенческой молодежи.

Ключевые слова: исследовательская компетентность, студент, образование, учебное исследование, вязкость, жидкость.

Аңдатпа

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СҰЙЫҚТЫҚТЫҢ ТҮТҚЫРЛЫҒЫН ЗЕРТТЕУ БАРЫСЫНДА БІЛІМ АЛУШЫЛАРДЫҢ ЗЕРТТЕУ ҚҰЗЫРЕТТІЛІГІН ҚАЛЫПТАСТЫРУ

Мақалада сұйықтықтың ішкі тұтқырлық коэффициентін зерттеу арқылы білім алушылардың зерттеу құзыреттілігін қалыптастыру әдістемесінің мақсаттары мен міндеттері қарастырылған. Зерттеу нәтижелері пәндік зерттеу құзыреттілігінің компоненттері мен негізгі құрылымдық элементтерін (білім алушылардың

зерттеу іс-әрекетін ұйымдастыру кезеңдеріне сүйене отырып ғылыми-зерттеу жобасын орындау логикасына негізделген зерттеу жұмыстарын орындауға дайындығы мен қабілеті) анықтауға мүмкіндік берді. Авторлар осы ұғымның кең ой-өрісі, арнайы құзыреттілігі, ақпараттық және коммуникациялық қызметтің ұтымды стилі бар болашақ мамандардың тұлғалық білім алуына байланысты негізгі құрамдас бөліктерін ашып көрсетті. Бұл құзыреттілікті қалыптастыруды практикалық іске асыру педагогикалық жоғары оқу орнының білім беру тәжірибесінің өзекті мәселелерінің бірі болып табылады, өйткені оның нәтижелері студент жастардың танымдық іс-әрекетінің ақпараттық және коммуникациялық мүмкіндіктері туралы заманауи түсініктерді тереңдете түседі, кеңейтеді және нақтылайды.

Түйін сөздер: зерттеу құзіреттілігі, білім алушы, білім беру, оқу зерттеуі, тұтқырлық, сұйық.

Introduction

Physical education is the basis for the training of specialists in the field of natural Sciences, engineering and technology. The modern stage of development of higher education in physical specialties is connected with the new achievements of physics and the integration of scientific research into the educational process, as well as the need for a high level of education, expressed through competence. From the above it follows that the formation of the research competence of students in improving the continuous and successive system of training of teaching staff in physical specialties is now an urgent task. Therefore, the country needs a specialist who is ready to be active in changing conditions, capable of independent analysis of the situation, constant self-development and self-improvement. Therefore, a student after graduating from a pedagogical University must have a certain set of competencies that characterize him as a person and as a future specialist. The goals and main objectives of education on the basis of competence approach are reflected in the State compulsory standard of higher and postgraduate education, developed in accordance with the law of the Republic of Kazakhstan "on education", establishing requirements for the content of educational programs of bachelor and master, educational trajectory of students, the structure and content of education, assessment of the level of preparedness of students and academic degree [1]. On SCS of the higher and postgraduate education in the maintenance of the educational program it is provided that all physical disciplines enter the block of the profiling disciplines (PD) consisting of the obligatory component (OC) and the component by choice (CC). The results of the training are determined on the basis of Dublin first and second level descriptors and expressed through the competence, both at the level of the entire program and at the level of the module and the individual discipline. Competence-based approach is systematic and interdisciplinary; it is characterized by personal and activity aspects, has a practical, pragmatic and humanistic orientation. Considering the competence approach as a basis for improving the professional training of students in paediatrics in the process of continuous training, it is important to use a set of interrelated multilevel research tasks necessary to master the basic research competencies. However, the formation of research competence should be seen as a complex multi-level dynamic process that proceeds in stages. having different aspects that should be studied are interrelated at all levels of training in technicalities. According to the content of educational programs of bachelor and master's degree programs, the formation of research competence should be based on professional knowledge, skills and attitudes to pedagogical work in the process of assimilating the fundamental subject knowledge, highlighting the ways and methods of their execution and application, on which the success of teaching a subject specialty physics depends the most. It should be noted that the main conceptual idea of teaching physics in the conditions of realization of the competence model of education is the emphasis on the elements of the content of this subject [2].

The structure of research competencies in accordance with Dublin descriptors is as follows:

Ability

- demonstrate developing physical knowledge and understanding, teaching about the principles, forms and methods of research;
- to reveal the situation for scientific and educational research in the material of studied physical disciplines;
- formulate the problem through theoretical or empirical research and solve it within the new framework of interdisciplinary areas related to the study area;

Know

- apply scientific methods of cognition in professional activity for disclosure of essence of the allocated physical situation at the level of physical objects, the phenomena, models and laws;
- to form tasks and criteria of theoretical or experimental research of the selected physical situation;
- at the stage of research planning to critically analyze existing concepts, theories and approaches to the study of physical processes and phenomena;

Preparedness

- study and analyze the theoretical material and prepare the conditions for the experimental study at the stage of preparation of the study;
- carrying out information and analytical and information and bibliographic work and generalization of results of experimental research and analytical work with involvement of modern information technologies;
- full implementation of the necessary empirical and theoretical physical methods of research, processing and analysis of the results.

Based on the analysis of the concepts of research competence in the works of different authors [3, 4], its components and structural elements, determining the objective relationship of research competence and research skills with the methodology of scientific research, it can be concluded: for students as the main structural elements (components) of the subject research competence in physics should be the willingness and ability to perform scientific or educational research in accordance with the stages., determined by the methodology of scientific research as a teaching about the organization of research activities.

When forming the research competence of students through the implementation of educational research in physics experimental methods are based on the appropriate methodological scheme that reveals the content and temporary structure of scientific research. Preparation of students for the implementation of educational studies of the coefficient of internal viscosity of the liquid is advisable to start with the study of the laws of molecular physics and hydrodynamics. 37 students in the specialties "5B011000-Physics", "6B01502-Physics" and "5B070300-Information systems"of Zhetysu University named after I.Zhansugurov took part in the pedagogical study of the results of the effectiveness of the influence of scientific research on the study of the viscosity of a liquid on the formation of research competence.

Methods

The phenomenon internal friction of a liquid exhibits when there is a relative shifting (displacement) of layers of fluid with respect to other layers (Figure 1). Generally speaking about this phenomenon is related to the transport (transfer) of the momentum of fluid particles which is connected with the dissipation of mechanical energy and its transformation into a heat. In the real fluids the internal friction is the result of interaction between its particles (molecules, atoms) and it characterizes the resistance which the fluid causes at the change of its flow under the action of external forces. When at a given study of a fluid its internal friction can be neglected, the fluid is called perfect (ideal) fluid. The basic (fundamental) law for the force of internal friction acting in the steady (stationary) laminar flow of a fluid is established by Newton [5]. The law is:

$$F = \eta \left|\frac{d\vartheta}{dz}\right| S,$$

where: F - is the force of internal friction acting between two separate neighbor layers moving with different velocity, S - is area of the frictional surface of the layers, $\left|\frac{d\vartheta}{dz}\right|$- is gradient of velocity (the change of velocity per unit distance perpendicularly to the velocity (along the Oz axis). When all layers move with the same velocities, gradient of velocity is zero and F = 0. The coefficient of proportionality ŋ in the Newton's law is called coefficient of internal friction (dynamical viscosity of the fluid). It is specific for a given fluid (liquid or gas) and considerably depends on the pressure and temperature. The viscosity is equal to the force of friction which acts on one square meter of two layers of the fluid apart at a distance of 1 m when the difference Δν between their velocities is of 1 m/s. The unit for viscosity is Pascal·second [Pa·s]. The quantity: ν=ŋ/ρ, where ρ is the density of the fluid, is called kinematic viscosity.

The measurement of the dynamic viscosity of a liquid can be carried out by special devices (apparatus) called viscosimeters. They work with laminar flow of the investigated liquid or a body streamlined by the liquid. The simplest viscosimeter is a long glass cylinder with radius R filled in with the investigated liquid. Small ball bearings are dropped into the liquid and fall down. When a spherical body with radius r, volume V and density ρ moves steadily with velocity υ through a liquid with density ρ, it experiences the following forces acting on it:

- the weight of a body: G1=m1g= ρ1V1g=4/3πr3 ρ1g
- the Archimedian force G2 is equal to the weight of displacement liquid by the body directed upward: G1=m2g= ρ2V2g= ρ2V1g =4/3πr3 ρ2g
- the drag force due to the viscosity of the liquid directed also upward. Its magnitude is determined by Stock's law: F=6πŋrυ.

In the beginning the velocity v of the ball changes and the motion is not steady. The drag force increases with the increase of velocity' When the drag force becomes equal to the difference: G_1- G_2, i.e. when the following condition is fulfilled:

$$F + G_2 = G_1 \tag{1}$$

the ball starts that moving uniformly with terminal velocity v_c.

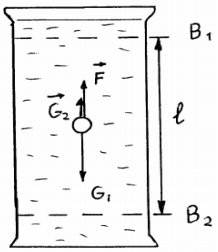

Figure 2. Studying of liquid's viscosity

If we substitute the forces G_1, G_2 and F in equation (1), we obtain:

$$6\pi\eta r\upsilon = \frac{4}{3\pi r^3(\rho_1-\rho_2)g} \tag{2}$$

So:

$$\eta = \frac{2(\rho_1-\rho_2)gr^2}{9\upsilon} \tag{3}$$

The terminal velocity v_c of the uniform fall of the body can be expressed by the distance is covered by the body per time t, i.e.

$$\upsilon = \frac{l}{t}$$

So the final expression for ŋ is:

$$\eta = \frac{2(\rho_1-\rho_2)gr^2t}{9l} \tag{4}$$

For a convenience:

$$\eta = kr^2t \tag{5}$$

Where:

$$k = \frac{2(\rho_1-\rho_2)g}{9l} \tag{6}$$

Formulas (5) and (6) are valid for an unlimited liquid, i.e. for a liquid with many large volume with respect to the volume of the body. Since the investigated liquid has limited volume (the liquid inside a glass cylinder with radius R) the coefficient k in (5) must be corrected as follows:

$$k' = \frac{2(\rho_1-\rho_2)g}{9l\left(1+\frac{2.4r}{R}\right)} \tag{7}$$

Then the final result for ŋ is:

$$\eta = k'r^2t \tag{8}$$

To assess the level of formation of research competence of students, the criteria and indicators described in [6, 7, 8] were used.

Based on indicators that allow qualitative and quantitative measurement and evaluation of the competence under study, the following levels were formulated: elementary level; basic level; advanced level.

At the elementary level of research competence formation, students are diagnosed with non-system knowledge of research logic and the possibility of using research methods. There are difficulties in solving research problems and lack of independence, insufficient perception and understanding of scientific information. As a rule, when performing tasks, they use an algorithmic method, performing productive actions based on a previously disassembled sample.

It is also difficult to analyze of information, present research results independently, select complex theoretical material, formulate conclusions and conclusions based on the results, and try to preserve the existing initial information without any adaptation, with excessive attention to details.

When forming a basic level of research competence, students are able to formulate physical definitions and concepts, describe the physical process being studied, and analyze the basic assumptions necessary to infer patterns; they are able to conduct a literature review, analyze and use a variety of information sources; they are able to choose and use various approaches and methods to solve problems of average complexity in physics. Apply the acquired knowledge in solving educational and research problems in the field of physics under the guidance of a teacher; they are able to plan and conduct research; they are able to interpret the data obtained, draw conclusions, and justify and protect the results of their work. Students are proactive and responsible for the results of their activities. However, the assimilation of knowledge is not systematic, at certain levels they lack the depth and strength of the assimilation of theoretical knowledge.

At an advanced level, students show knowledge and understanding of scientific principles and methods of research activities, awareness of advanced scientific knowledge, achievements in the field of physics; the ability to explain the prospects for the development of physics and independently conduct a literary review, analyze, highlight the necessary information; the ability to analyze, select, use and independently master modern methods for solving research problems in physics. Know how to formulate setting research goals, knowledge and skills when solving in physics; planning a study (project) and to implement it, and evaluate the effectiveness of research for improvement; analyze, summarize and critically evaluate research results, make predictions, and draw conclusions; able to analyze the results of their work and their ability to represent and defend on a scientific level (to prepare a scientific publication on the results of the study).

Results

A long glass cylinder filled in with the investigated liquid (glycerin) is used. On the wall of cylinder there are two horizontal marks B1 and B2 at length of l apart. For spherical small bodies lead balls (pellets or ball bearings) are used. To avoid clinging (adhering) of air bubbles on them they are wetted in advance. Ten balls (pellets), with medium size, are chosen. The diameter d of every one is measured in advance with micrometer screw-gauge. The pellet is placed between the jaws of the micrometer screw gauge and to avoid an excessive pressure on the pellet, and so to change its diameter, further rotation of the spindle must be done by the ratchet. The time t is measured by stop-watch: this is the time for which the pellet with radius $r = \frac{d}{2}$ covers the distance I between both marks B_1 and B_2. The pellet must fall down along the axis of cylinder. In order to avoid parallax error your eyes must be located directly at the both marks when the pellet passes alongside with them (your eyes must be at same level with B_1 and B_2). The results are shown in the table 1.

Table 1. The results of the laboratory work are given

№	D, mm	T, s	L, cm	ρ_1, kg/m^3	ρ_2, kg/m^3	η, Pa·s	Δη, Pa·s	ε, %
1	3	25	83	11350	1260	1,4892	0,00741	0,96
2	2.8	29	83			1,5048	0,00819	
3	2.5	37	83			1,5305	0,03389	
4	2.3	42	80			1,5257	0,02909	
5	2	53	80			1,4558	0,04081	
6	1.8	67	80			1,4906	0,00601	
7	1.6	80	75			1,5001	0,00349	
8	1.3	120	75			1,4854	0,01121	
9	1.1	168	75			1,4889	0,00229	
10	0.9	252	75			1,4951	0,00151	

Experimental (2019-2020, 19 students) and control (2019-2020, 18 students) groups of students were selected for the study. For visual perception of information, the results of the experiment are presented in the table 2.

Table 2. Results of measurements of the development of research competence of the control and experimental groups before and after the experiment

Level of knowledge	*Control group*	*Experimental group*	*Control group, %*	*Experimental group, %*
Before the experiment starts				
Advanced	*4*	*5*	*22,2*	*26,3*
Basic	*8*	*9*	*44,5*	*47,4*
Elementary	*6*	*5*	*33,3*	*26,3*
After the experiment ends				
Advanced	*7*	*10*	*38,9*	*52,6*
Basic	*7*	*8*	*38,9*	*42,1*
Elementary	*4*	*1*	*22,2*	*5,3*

For a visual perception of the information, the results of the experiment presented in the table 1, a diagram is constructed. The diagram shows changes in the levels of development of research competence of students in the experimental and control groups during the pedagogical experiment (Fig. 2).

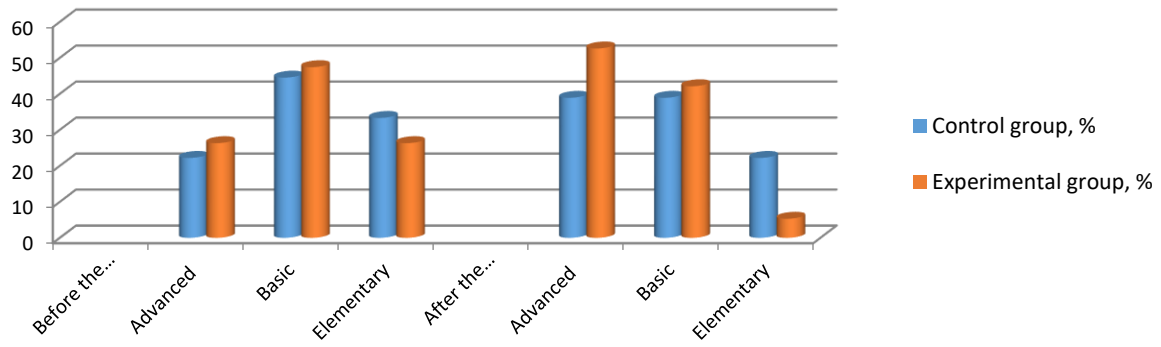

Figure 2. The level of development of research competence of the control and Experimental groups before and after the experiment.

Discussion

In laboratory classes, students of the control group were asked to conduct research independently; process the results of the experiment and issue them in writing. The experimental group additionally tested the results of research and presented the results in the form of a computer presentation, reflection for the purpose of critical analysis of the work done and its results, determining the direction of new physical experiments and empirical research. After the work was completed by the students, the results of the experimental and control groups were compared. The results showed that the quality indicators in the experimental group exceeded those of the control group. The results of the pedagogical experiment show that the implementation of methods of influence of scientific research on the determination of fluid viscosity on research competence shows a positive dynamics of changes in the levels of development of the desired competence of students according to all criteria. According to the results of measuring research competence at the control stage: 26.3% of the total number of students were at the elementary level of the required competence, 47.4% at the basic level and 26.3% at the advanced level. By the end of the experiment, the following data were obtained: 5.3% was recorded at the elementary level, 42.1% at the basic level, and 52.6% at the advanced level. this makes it possible to create conditions for the gradual development of research competencies.

The study of the goals and objectives of the method of forming the research competence of students, on the example of the study of the coefficient of internal viscosity of the liquid, allowed to establish the components of the subject of research competence and to find out its main structural elements - the readiness and ability of students to perform educational research, following the stages of the organization of research activities, which are based on the logic of the research project.

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