CHAPTER 3
THEORY AND METHODS OF VOCATIONAL EDUCATION

PROBLEM-BASED LEARNING IN HIGHER SCHOOL (ON THE EXAMPLE OF TEACHING PHYSICS)

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Abstract. *Problem-based education is considered as a method of forming the professional culture of students of higher educational establishments. Approaches to the formation of students' professional culture in physics classes are considered. Although the concepts of problem-based learning can be applied to the study of any discipline, their use in learning a foreign language is very difficult. The author's definition of problem-based is presented. One of the benefits of problem-based learning is that students' communication skills are improved more effectively than traditional methods. A brief comparative analysis of problematic and task learning methods, algorithm (stages, content) of solving problem situations and learning tasks is given. The central concept of problem-based learning is problem. Students are offered problematic situations that have a professional and ethical focus. The right problematic situation is an emphasis on teamwork, as opposed to approaching the division into groups for victory. In the process of solving problematic situations of a professional and ethical nature, such areas of the student's personality are involved as cognitive, sensually emotional, axiological, and activity. The role of the teacher in solving problem situations is considered. The conclusion about the influence of problem-based learning on the professional culture of students has been formed. Analysis of advanced pedagogical experience, methodological literature, observations and experimental work made it possible to single out the didactic requirements for the creation of problem situations. The three groups of motives associated with traditional and active forms of education are given.*

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Introduction. The main goal of modern education is for specialists to master the methodology of creative transformation of the world. The creative process includes, first of all, the discovery of something new: new objects, new knowledge, new problems, new methods of solving them. In this regard, problem-based learning as a creative process is presented in the form of solving non-standard scientific and educational problems by non-standard methods. If training tasks are offered to students to consolidate knowledge and practice skills, then problem tasks are always a search for a new way of solving. As a psychological category, it reflects the contradictions of the subject in the cognition of the object. The same problem by different people or different groups of people can be perceived differently, cause difficulties in its comprehension, be perceived as a problematic task, in which the essence of the problem is formulated and the stages of its solution are outlined.

Literature review. Problem-based learning is the creation of non-standard situations, during which trainees acquire new knowledge, skills and abilities.

The formation of students' professional thinking is the development of a creative, problematic approach. University training should form the necessary creative abilities in a specialist.

Elements of problem learning took place as far back as antiquity and then during the Renaissance. These are heuristic conversations of Socrates, conversations and dialogues of Galileo. Pedagogy J.-J. Rousseau – problematic dialogues – were a favourite genre of the Age of Enlightenment. In the history of pedagogy, the lectures of K.A. Timiriaziev can serve as an example of problematic presentation of material.

Aims. The purpose of the article is to study the features of problem learning in higher education (on the example of teaching physics).

Methods. During the writing of the article the following methods were used: the method of historical comparison, methods of analysis and synthesis, the method of generalization and others.

Results. The essence of the problem interpretation of the educational material is that the teacher does not communicate knowledge in a finished form, but sets problematic tasks for the students, prompting them to look for ways and means of solving them. The problem itself paves the way for new knowledge and ways of acting.

New knowledge is given not for information, but for solving a problem or problems. With the traditional pedagogical strategy - from knowledge to problem – students cannot develop the skills and abilities of independent scientific research, since they are given ready-made results for assimilation. Hegel aptly defined the role of scientific search, saying that not the result is a real whole, but the result together with its formation. The naked result is a corpse that has left behind a trend.

Traditional lecture. It is necessary to give and clarify some physical concepts (absolutely black body), then explain the basic concepts of quantum theory, communicate the main characteristics (for example, the distribution of the intensity of thermal radiation over frequencies), then derive the main and derivative formulas and show what scientific and technical problems can be solved using this conceptual apparatus.

In any activity, the main thing is the result. The result of the educational process is changes in knowledge, abilities, attitudes, holistic orientations. The result of the educational process can be achieved using various teaching methods and methods of activity.

In physics lessons, problem learning can be applied very widely, and at all stages of the lesson. For example, when studying theoretical material, you can apply the problem – actualizing the use of this phenomenon in the profession (various uses of static electricity by auto mechanics, operators, welders). Physical material makes it possible to create many problem situations, guide the cognitive activity of students, teach them to learn and use knowledge in the profession.

In problem-based teaching, a physics teacher, presenting the material and explaining the most complex concepts, systematically creates problem situations in the lesson. The teacher organizes educational and cognitive activities in such a way that, based on the analysis of facts, observation of phenomena (in a demonstration or

frontal experiment), they independently draw conclusions and generalizations, formulate rules, concepts, laws, apply their knowledge in a new situation.

The successful solution of this task will be facilitated by the use of problem-based learning, which:

- ensures the strength of the assimilation of knowledge;
- makes the learning process more attractive and interesting;
- teaches to apply knowledge in practice;
- develops analytical, logical thinking of students;
- promotes the teacher's creative growth;
- forms the student as an active subject of cognition.

The problem type of learning differs in that the teacher creates a certain cognitive situation, helps students to highlight the educational problem, understand it and "accept"; organizes them for independent mastering of a new volume of knowledge necessary to solve a problem; offers a wide range of ways to use the knowledge gained in practice.

Let's present a *problematic lecture*. The lecturer talks about the ultraviolet catastrophe, about the problem of the discrepancy between the theoretical curves and the curve obtained experimentally, about the distribution of radiation intensity in the frequency spectrum. It is then helpful to tell students about the painful scientific quest of scientists that led to quantum theory. What does the permutation of terms give? Starting with an allegedly unsolved problem, the teacher creates a problem situation in the group, forming in the students' minds the motive for mastering the frontier of scientific knowledge. Only motivation can become an effective factor in the active involvement of a person in the process of cognition. Motives arise from needs, and needs are determined by experience, attitude, assessment, will, emotion.

Creative thinking requires solving the problem of inclusion. Reproductive mental processes associated with the reproduction of learned patterns are simply useless in a problem situation.

Subject-object-subject relations contribute to the activation of creative thinking arising from the collective solution of certain problems. Some psychologists adhere to the division of motives into two groups. In both cases, the division occurs depending on what is the basis of motivation or need for knowledge. The three groups of motives given below are associated with traditional and active forms of education.

In traditional teaching, trainees form two groups of motivating motives:

I - directly motivating motives;

II - promising motives;

III - cognitive and motivating motives of the disinterested search for knowledge, truth.

Throughout the lesson, the teacher introduces the students to the essence of the problem, causes a contradiction between the knowledge, skills and abilities that they possess, and those facts, laws, phenomena that are reported to them. In order for a situation to become problematic, it is necessary that they be able to resolve it. This means that those questions become a learning problem, the answers to which are not

contained in the already existing knowledge of students, cause intellectual difficulties, but are feasible for them.

Analysis of advanced pedagogical experience, methodological literature, observations and experimental work makes it possible to single out the following didactic requirements for the creation of problem situations:

1. The educational problem should be related to the material being studied and follow from the logic of the cognitive process.

2. Problems should create cognitive difficulties that arise from objective contradictions inherent in the studied material.

3. Problem questions should be feasible for students.

4. A problematic question must necessarily encourage the expression of new ideas.

5. Problematic issues should be based on previous experience and existing knowledge.

6. The main content of the problem should guide the cognitive search of students.

7. Problematic issues should influence the emotional state of students, interest them in the content and methods of solution, intensify the activities of students, and positively influence the motivation of learning.

When creating problem situations, one should also take into account the level of knowledge of students, psychological characteristics and intellectual capabilities. Otherwise, students may lose interest in solving the problem if they will not be able to do it.

Consider a system of techniques for creating problem situations.

1. A situation of surprise arises when students are familiarized with facts, phenomena, experiences, conclusions that cause surprise, seem unusual, paradoxical. For example, teacher asks the question: «Can water boil at room temperature?», Which serves as the basis for creating a problem situation. By showing the famous experience of boiling water at room temperature, the teacher creates a situation of surprise.

2. The situation of conflict is used mainly in the study of physical theories and fundamental experiments. Such situations have often arisen in the history of the development of physics. For example, the teacher begins the study of wave interference by demonstrating water waves. Students observe wave fronts from a point vibrator and then from two point coherent vibrators. In this case, a conflict arises – the students observe «frozen» wave fronts in the form of symmetrical stripes. Why did the picture change from dynamic to static and change its appearance? By considering this conflict, students explore the essence of the wave interference phenomenon.

3. The situation of foresight is the teacher's hypothesis about the possibility of the existence of a certain pattern or phenomenon with the involvement of students in a research search. For example, teacher makes the following prediction: «It is known that the appearance of an electric current is always accompanied by the appearance of a magnetic field. Is it possible to get the opposite phenomenon: to induce an electric

current in a conductor using a magnetic field?» Discussing various options for solving the problem, the students, as a result of the discussion, come to study the well-known experience of M. Faraday related to the discovery of the phenomenon of electromagnetic induction.

4. A situation of refutation is created when students are asked to prove the impracticability of any idea, project, proof, antiscientific conclusion. For example, it is proposed to prove the impossibility of creating a certain project of a perpetual motion machine, or the existence of too large insects on the Earth, or movement at a speed exceeding the speed of light in a vacuum, and the others.

5. The situation of discrepancy lies in the fact that the life experience of students, the concepts and ideas that have developed in them spontaneously, come into conflict with scientific data. For example, when studying the Archimedean force, the following question is proposed: «There are two identical vessels filled to the brim with water. A wooden block is floating in one of them. Which of these vessels is the heavier?» The students believe that the vessel in which the bar floats will be heavier (since excess substance is added). Some believe that a vessel without a bar will be heavier (vessels are filled to the top, and the density of wood is less than that of water). Weighing the vessels shows that their weight is the same. Why? The solution to this problematic problem leads to the establishment of the law of floating bodies.

6. A situation of uncertainty arises when the proposed problem is problematic - the task has insufficient data to obtain an unambiguous answer. For example, it is known that the resistance of metallic conductors increases with increasing temperature. I ask the question: «How will the resistance of semiconductors (or electrolytes) change when heated?» Students cannot give an unambiguous answer due to the fact that they do not know how a new substance (semiconductor or electrolyte) will behave with an increase in temperature, what processes, changes in the state of a substance will be accompanied by heating. While solving the problem, the concept of the dependence of the resistance of semiconductors (electrolytes) on temperature is formed.

The problem-based lesson has the following structure:

I. Statement of the educational problem.

II. Statement of the educational task.

III. Finding a solution.

IV. Decision Expression.

V. Product implementation.

Thus, problem learning begins with the creation of a problem situation – the main means of activating the mental activity of students and then goes through the main stages: the formation of a problem, finding ways to solve it, solving the problem, formulating conclusions, summing up the results.

So, cognitive-stimulating motivation appears when using active teaching methods and, having arisen, turns into a factor in activating the educational process and the effectiveness of teaching. Cognitive motivation encourages a person to develop his inclinations and capabilities, has a decisive influence on the formation of the personality and the disclosure of his creative potential.

With the emergence of cognitive-stimulating motives, there is a restructuring of perception, memory, thinking, a reorientation of interests, an activation of a person's abilities, creating the prerequisites for the successful implementation of the activity in which he is interested.

The inertia of traditional pedagogy is still very high and focuses mainly on the stimulation of motivating motives, on the motivation for achievement: to get high scores, to successfully pass the session, etc. Therefore, the identification of psychological and pedagogical characteristics that contribute to the emergence of cognitive motivation with its subsequent transformation into professional motivation is one of the strategic directions for the development of higher education pedagogy and innovative teaching technologies.

That is why the teacher should organize pedagogical and interpersonal communication in such a way and so direct the educational activities of students so that achievement motivation does not hinder the emergence of cognitive motivation.

Discussion. The task of problem learning is the formation of motives. Its success is determined by the logic and content of the student's activities. The most important feature of the content aspect of problem learning is the reflection of objective contradictions that naturally arise in the process of scientific cognition, educational or any other activity. As a result, problem learning can be called developmental, because its goal is the formation of knowledge, hypotheses, their development and solutions.

To formulate a problem correctly means already half of it. But at the initial stage of the solution, the formulation of such a problem does not contain the key to its solution.

Although the teacher knows the shortest path to solving the problem from the very beginning, his task is to orient the search process itself, leading students step by step to solving the problem and gaining new knowledge.

Some authors define problem learning as a series of problematic tasks, the consistent solution of which leads to the achievement of the set didactic goal.

Conclusion. As a result of research and practical activities, three main conditions for the success of problem learning have been identified:

- providing sufficient motivation that can arouse interest in the content of the problem;
- ensuring the feasibility of working with the problems that arise at each stage (a rational ratio of the known and the unknown);
- the significance of the information obtained in solving the problem for the student.

So, the main psychological and pedagogical goal of problem learning - the development of professional problem thinking – in each specific activity has its own specifics. In general, the development of creative abilities is of an applied nature and is concretized in relation to the subject, transforming into the formation of a particular creative ability, into a non-standard vision:

- to see the problem in a trivial situation when students have questions that are non-trivial for a given level of training such as: "Can any curve be set by a system of two equations?";

- to see in a new way the structure of a trivial object (its new elements, their connections and functions, etc.), for example, the coinciding outlines of the continents of both America, Europe and Africa;

- to form the ability to transfer previously acquired knowledge and skills into a new situation (the formation of meta-skills);

- to combine a new way of solving the elements of previously known methods. For example, the transfer of methods of chemical, psychological, graphological, mathematical analysis to forensic examination;

- to construct original solutions without using previously known similar methods (this is how non-Euclidean geometry was created by Lobachevski, the theory of relativity by Einstein, quantum physics by Planck).

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