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GENERALIZATION AND SYSTEMATIZATION OF STUDENTS' KNOWLEDGE IN PHYSICS

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Abstract: *In the article, the use of systematization not only organizes human knowledge about objects of knowledge, but also serves as a source of new knowledge. The selection of educational material is carried out taking into account the system: a number of phenomena related to each other are studied, and at the same time taking into account the principle of "from simple to complex". In each section, educational information is systematized around core concepts.*

Keywords: *principle, systematization, analysis and synthesis, comparison and classification, scientific facts, concepts, laws, theories, physical quantities, physical picture of the world, information, generalizations, body, substance, field, interaction, energy.*

1.Introduction.

The objectives of teaching physics are to develop in students deep, solid and effective knowledge, the fundamentals of physics and their practical applications, knowledge of the methods of natural science cognition and the structure of scientific knowledge, the development of their thinking, etc. One of the ways to solve these problems is to organize special work on generalizing and systematizing knowledge.

Systematization is understood as a mental activity in the process of which the objects of study are organized into a certain system based on the selected principle. During systematization, such mental operations as analysis and synthesis, comparison and classification are carried out, during which students highlight the similarities and differences between objects and phenomena, group them in accordance with the selected features or grounds, establish cause–and–effect relationships, essential relationships between objects and phenomena. In the process of systematizing knowledge, not only semantic, cause–and–effect, but also structural connections are established, in particular, connections between the components of the structure of elements of physical knowledge: connections within physical concepts, laws, theories, picture of the world. In this case, the task of forming the systematicity of students' knowledge is solved [1].

Psychologists note that students' knowledge is deeper and more solid if it has been systematized and generalized. Systematization allows the use of memory, since it frees it from the

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need to remember material as a sum of private information and facts by grouping them into larger units. The very mechanism of human perception of information is associated with the activity of systematization: when perceiving new information, we compare it with already known knowledge (association), we try to group new information.

2.Main part. The use of systematization not only organizes a person's knowledge about the objects of knowledge, but also serves as a source of new knowledge. The teacher must introduce students to the methods of systematization so that they can apply them independently. Systematicity is a quality of knowledge that is characterized in the student's mind by the presence of logical connections between the components of the phenomena being studied. The selection of educational material is carried out taking into account the system: a number of phenomena related to each other are studied, and at the same time taking into account the principle "from simple to complex". In each section, educational information is systematized around core concepts. For example, in mechanics – point, body, substance, field, interaction, energy.

The methodological basis for the systematization of students' knowledge is the systems approach accepted in science – a methodological tool for studying integrated objects and integral dependencies and interactions, which allows, on the one hand, to give a general idea of the process, phenomenon, object, and on the other hand, to see their components, the connections between them, the place of this system in the composition of another, more complex [2].

The objective scientific basis for the systematization of students' knowledge is the peculiarities of physical science and physics – a subject distinguished by the logical consistency of both the scientific knowledge itself and the process of its formation.

The didactic basis for the systematization of students' knowledge is the patterns of assimilation of knowledge and methods of activity by students, reflected in the principle of systematicity and consistency in teaching, as well as in the principle of systemicity.

The psychological basis for the systematization of students' knowledge is the formation of associative links: local, particular–system, intra–system and inter–system. In the first three cases, the systematization is mainly intra–subject in nature; in the fourth – inter–subject. Accordingly, several objects of knowledge systematization in physics can be distinguished:

– scientific facts (phenomena, processes);

– physical concepts, including physical quantities;

– physical laws;

– physical theories;

– general scientific methodological principles;

– physical picture of the world.

In addition, knowledge can be systematized based on certain core ideas of the course. In particular, it is advisable to systematize applied knowledge in accordance with the main areas of scientific and technological progress, ideological and methodological knowledge in accordance with the cycle of scientific knowledge or based on the philosophical categories of matter, motion, space–time, interaction, ideas about which develop as the course is studied. In the case of systematization of knowledge at the interdisciplinary level, we should talk about general natural science concepts, laws, theories and the picture of the world [3].

The object of systematization depends on the stage of studying the physics course at which it is carried out. Thus, at the end of studying the topic, knowledge about physical phenomena, concepts, quantities and laws is systematized; at the end of studying the sections – about physical theories; at the end of studying the course – about the physical picture of the world; before presenting new material, it is important to summarize what was studied in previous lessons.

The didactic role of knowledge systematization is that the unification of knowledge about facts, phenomena, patterns, principles into a system allows to reveal new connections and relationships between them that were previously unknown to students, to make generalizations of an ideological nature and turns systematization into a means of cognition. The level of formation of the students' knowledge system is an important indicator of their intellectual development, it determines the ability of students to cope with new cognitive tasks, to restructure knowledge, to include it in new systems, i.e. serves as an indicator of the ability of students to carry out creative activities. In the process of systematization, the attention and activity of students are aimed at identifying the main thing, at combining many isolated facts into groups, which allows to organize knowledge, unload memory, more fully grasp and comprehend information. In this case, generalization of students' knowledge often occurs, which consists in the mental unification of objects and phenomena that are similar in some features. Generalization involves the initial study of objects, identifying the general and the special in them, combining them into groups according to selected features, dividing them into types, etc.

Generalization of knowledge is a transition to a higher level of abstraction by identifying common features (properties, relationships, connections, etc.) of objects and phenomena. Generalization of knowledge leads to a significant change in their quality, to the assimilation of the core of knowledge, its system. In this sense, generalization is closely related to the principle of

generalization, which assumes that the result of student learning is a system of knowledge in which the particular is subordinated to the general, the inessential and secondary to the main. The generalization of students' knowledge and skills in physics is facilitated by the so–called generalized plans for studying certain elements of knowledge, the formation of certain experimental skills, developed by A.V. Usova [4].

There are several types of knowledge systematization. The most important is classification – a type of systematization in which the unification of objects occurs on the basis of certain essential features, which allows us to identify the essential, the general, which unites objects into a system, and their specific differences [5].

Another type of systematization is the establishment of logical–genetic connections reflected in the definition of concepts.

Systematization of knowledge can be aimed at establishing cause–and–effect relationships between phenomena. In particular, after studying the initial information about the structure of matter, students can be asked to explain a number of phenomena based on certain provisions of the molecular–kinetic theory and compile a corresponding table. When studying the electric field, the teacher very often turns to establishing cause–and–effect relationships, for example, when studying a rheostat and its operating principle.

Systematization can be carried out by comparison, i.e. establishing similarities, differences or analogies between objects and phenomena. In this case, the similarity or difference is not only established, but also their causes are explained. An example is the comparison of electrostatic and gravitational fields, electrostatic and magnetic, etc. The results of the work on generalizing and systematizing knowledge can be presented in the form of tables, diagrams, charts, reference notes.

Systematization and generalization are closely related in the process of processing the received educational information. The teacher should use the natural processes of systematization and generalization of the received information, which flows spontaneously in schoolchildren. This need is explained by the fact that the sharply increasing flow of information presented in the old way, students do not have time to process and assimilate, which reduces academic performance and causes a loss of interest in the subject and learning. Several approaches can be noted in carrying out systematization and generalization:

– considering the means of generalization, they distinguish diagrams, tables, graphs, systems of equations, classifications with the establishment of cause–and–effect relationships;

– speaking about time, we can indicate – at each lesson, after studying a topic or section,

at the end of the school year in generalizing lessons;

– the form of presentation – the teacher himself carries out systematization and generalization in the lesson; does this together with the students in the lesson; gives students a similar task to complete independently in class or at home.

Providing students with a system of knowledge is one of the most important tasks of teaching physics. The principle of systematicity and consistency in teaching has long been proclaimed in didactics. It assumes: a) studying the material in a certain sequence, corresponding to the logic of science, the foundations of which are studied at school; b) forming a system of scientific concepts, abilities and skills in schoolchildren. This principle underlies the construction of curricula, determines the system of the teacher's work and the activities of students in the learning process.

Systematization is not limited to classification. Systematization is also caused by the establishment of cause–and–effect relationships and relations between the facts being studied, the identification of basic units of material, which allows us to consider a specific object as part of a system. Systematization is preceded by analysis, synthesis, generalization, comparison, the results of which are used and summarized in systematization.

Systematization of the mechanics course.

When teaching mechanics in a comprehensive secondary school, certain educational, developmental and developmental tasks of students are solved. Educational tasks are determined primarily by the fact that mechanics introduces basic concepts (mass, force, momentum of a body, energy, etc.), which are the "tool" of cognition in science – physics. In this sense, mechanics can rightly be considered the foundation of physics. In mechanics, students get acquainted with physical theory – Newton's classical mechanics and such generalizations as the law of universal gravitation, the laws of conservation of momentum and energy, general conditions of equilibrium of mechanical systems.

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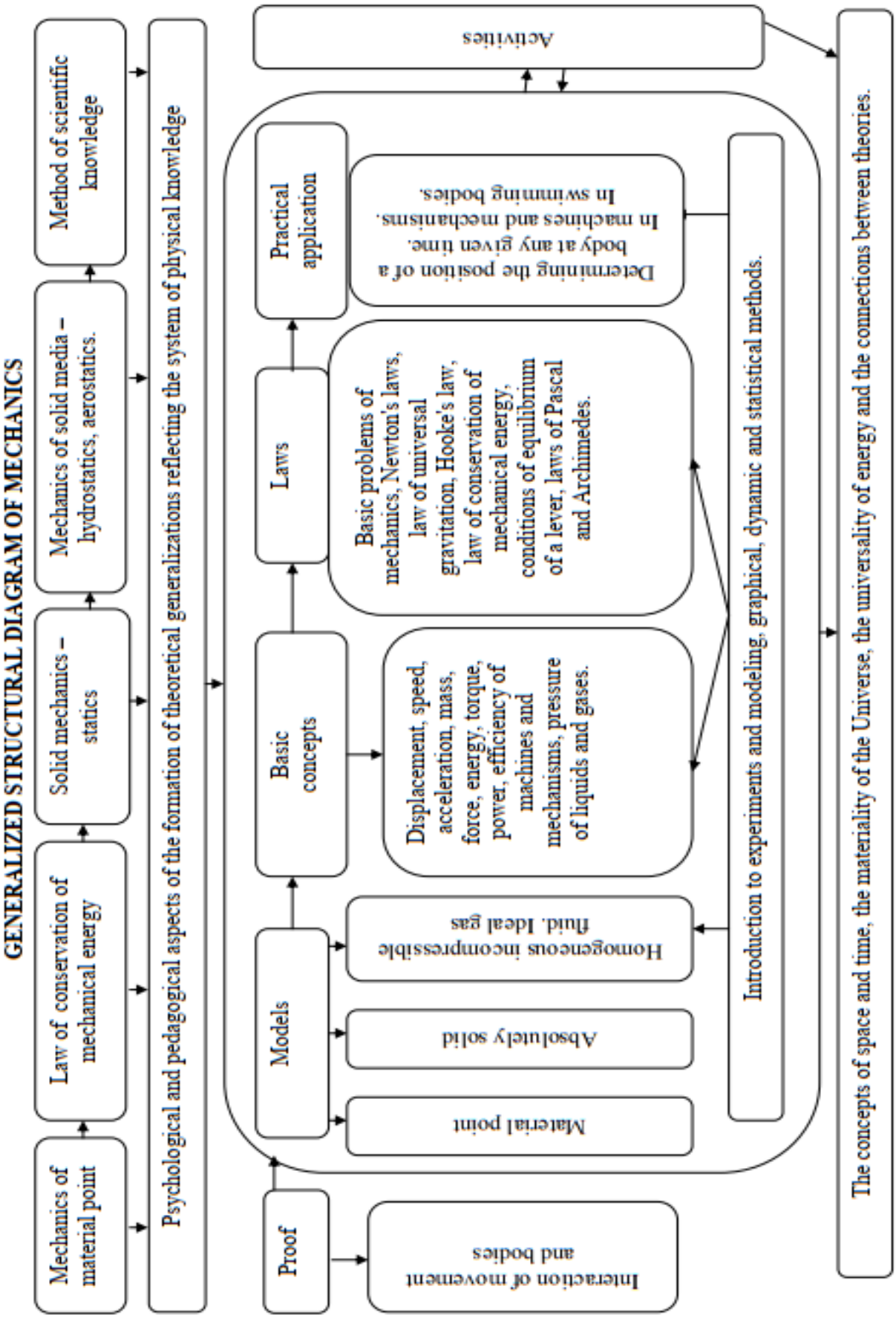

Educational tasks (formation of a scientific worldview) are solved by means of a dialectical–materialistic view of nature and its cognition, the formation of polytechnic knowledge and skills (knowledge of the scientific foundations of modern mechanization of industry, transport and agriculture), disclosure in physics lessons of the main directions of development and acceleration in modern production, education of patriotism and internationalism, labor education. The basis of labor education in physics lessons when studying mechanics is polytechnic education, during which schoolchildren are introduced to one of the main areas of modern production – mechanization. Students learn about simple mechanisms, various types of motion transmission, laws of motion, etc. During laboratory work, they master some practical skills in handling measuring instruments.

The solution to the problems of developmental education in the study of mechanics is aimed at developing logical, theoretical, scientific and technical, dialectical and, consequently, at developing their intellect and creative abilities. The harmonious and logic of mechanics, the broad reliance in mechanical theory on such general methods of cognition as analysis and synthesis, induction and deduction contribute to the development of logical thinking of schoolchildren. The presence of scientific generalizations in mechanics contributes to the formation of theoretical thinking, the peculiarity of which is the ability to highlight the main thing reflected in abstractions, and to extract specific conclusions from the latter, moving from the general to the particular.

In mechanics, schoolchildren encounter a large number of abstract concepts – a material point, a frame of reference, uniform and uniformly accelerated motion, etc. When examining these concepts, students are taught to highlight the essential features of phenomena and objects, discard inessential ones, and are shown how idealization arises in science and how abstraction occurs.

Reference to physical theory (classical Newtonian mechanics) helps to form in schoolchildren an understanding of the physical picture of the world – one of the most general forms of reflection of nature by physical science and one of the components of the scientific worldview, shows the dialectic of views on the physical picture of the world and the place of mechanical theory in this picture. When studying the main generalizations (the law of universal gravitation, the laws of conservation of momentum and energy, general conditions of equilibrium, etc.), students are explained that the objectivity of scientific generalizations is confirmed by their application in the practical activities of people (the mechanics of space flights, the movement of machines and their parts, the implementation of equilibrium conditions in technical structures). Studying the causes of changes in the speed of movement and deformation helps to reveal cause–

and–effect relationships. Determining the limits of applicability of classical mechanics helps to illustrate the knowability of nature and the infinity of the process of cognition. All this contributes to the formation of dialectical thinking.

Let's consider the main features of the mechanics course. The first feature is that mechanics is the beginning of the physics course in high school. This determines the place of mechanics in the general education physics course and requires the teacher to pay attention to the students' solid assimilation of the material. The second feature is that mechanics presents physical theory quite fully. Therefore, the teacher is given the opportunity to illustrate the structure of physical theory using mechanics as an example. And the third feature is the use of an experiment in teaching mechanics.

At the stage of generalizing and systematizing knowledge in the mechanics course, you need to refer to Table 1. Thus, repetition and consolidation of the material will be accompanied by the formation of multilateral connections between the studied material and on the basis of problematic issues and solving cognitive tasks. Of course, you can write down all the known formulas and formulate the basic laws, although this work should be offered as an advanced homework assignment, or you can diversify the activity by compiling situational tables on the topic or using ready–made material. The convenience of the table is obvious: generalization and repetition are reduced not to the formal restoration of existing knowledge, but to the construction of a closed image of the phenomena and processes under consideration.

3.Conclusion. The work reveals the essence of systematization and generalization in physics lessons. The role of these processes is great, since not only the quality of the assimilated material improves, but also the ability to analyze, abstractly represent many concepts and definitions develops.

One of the problems of teachers is the understanding of generalization as a usual repetition of material, consisting in remembering formulas and solving problems. In fact, systematization and generalization is a broader concept, including creative tasks that contribute to the development of analytical thinking.

Thus, the work fulfilled the set tasks: a ascertaining experiment was conducted, articles and educational materials on this issue were reviewed and analyzed, tables and diagrams were compiled based on the studied material.

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