METHODOLOGY OF SELECTION AND SOLUTION OF INTEGRATION PROBLEMS ON PHYSICS

G.R.Khasanova
Senior teacher at military academic-lyceum “Temurbeklar maktabi”
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Abstract. *The article presents the pedagogical experience on the method of developing the creative thinking of students using integrative technologies in teaching physics in secondary specialized educational institutions.*

Keywords: *physics teaching methodology, creative thinking, integrative technology, non-standard task.*

Today, integration processes are actively developing in various spheres of human activity. The integration of sciences is also reflected in the education system. Integrative courses, educational topics, lessons, special courses and elective courses, elective subjects are being developed. In the studies of some Russian scientists (G.A. Bordovsky, V.N.Maksimova, I.I.Sokolova, V.P.Solomin, etc.), the importance of integrative education in modern education was noted in connection with the increasing need for specialists with new, systematic and integrative thinking skills [1].

The problem of developing students’ creative thinking is becoming one of the fundamental problems in the development of modern physics education, and therefore it is being studied in depth by many disciplines, including the methodology of teaching physics. The analysis of research on this problem shows that the following issues have not been fully explored in pedagogical theory and practice:

- comprehensive development of the student’s thinking in various forms of educational and cognitive activity in teaching physics;
- formation of generalized skills of solving physics problems and generalized experimental skills;
- the theory of development of students’ natural-scientific thinking has not been developed.

The above problems have not been sufficiently developed methodologically and technologically.

In fact, the development of human thinking is a complex, interdisciplinary subject of research by philosophers, psychologists, logicians, sociologists, and physiologists. According to some dictionaries, “Philosophy studies the relationship between matter and thinking, the possibilities and methods of knowing the world with the help of thinking. Sociology deals with the analysis of the historical development process of different societies depending on the social structure. Physiology studies the brain mechanisms by which thought actions are performed. Cybernetics considers thinking as an information process that identifies commonalities and differences in the functioning of a computer and human mental activity. Psychology studies thinking as a cognitive activity, distinguishes its types according to the levels of generalization and the nature of the tools used, their novelty for the subject, the level of activity, adequacy of thinking to reality” [4].

A person with developed creative thinking can not only occupy a worthy place in society, but also make a sufficient contribution to the development of society. In this regard, high

requirements are placed on secondary special vocational education in terms of the formation of students' creativity, which opens up the opportunity for graduates of educational institutions to create new methods and types of activity, to engage in new professional activities. Teaching physics is based not only on the transfer of information, but also on “learning to think”, (L.Sekey, S.Mednik, J. Renzulli, R.Stenberg, K.Taylor, E.Torrens and others) and Russian scientists (D.B. Bogoyavlenskaya, A.V.Brushlinsky, L.S.Vygotsky, V.V.Davidov, V.N.Druzhinin, I.Ya.Lerner, A. Ya.Ponomarev, M.N.Skatkin and others) it was recognized that the formation and development of a person's creative thinking can be carried out not only under the influence of upbringing and everyday life conditions, but also in the process of purposeful learning using active teaching methods (A.A.Gin, S.I.Gin, N.I. Derekleeva, M.I.Meerovich, L.I.Shragina and others).

Our analysis of instructional practices has shown that instruction that develops student thinking is rare and that inefficient, usability-oriented technologies are often used. Not enough attention is paid to the methods of forming students' theoretical thinking. In this regard, it became known that the lack of qualifications of teachers for the formation and development of students' systematic knowledge of science, generalized skills, theoretical natural science thinking. Currently, they face the problem of competent organization of specialized education, optimal selection of new pedagogical technologies, tools, methods and teaching methods in various vocational educational institutions.

Examples of tools for developing students’ creative thinking include problem-based presentation of educational material from physics, conducting research while performing laboratory work, and students’ research activity, solving creative problems. In the studies of many pedagogical scientists (G.S.Altshuller, G.L.Ball, O.O.Makarycheva, D.Poya, L.M.Fridman, etc.), the development of creative thinking in the process of solving heuristic, research, design issues in science, the specific features of creative tasks determined.

The formation of the fundamentality and integrity of general and secondary special education, the value system, including environmental education without natural sciences, especially physics education, the achievement of methodological and information skills, critical and logical thinking, comprehensive and multifaceted development cannot be ensured. It is impossible to properly form and educate the student’s personality. For modern, competitive personnel, it is important to be able to solve important practical tasks that require integrative knowledge and methods of action [1].

In the methodology of teaching physics, great attention is paid to solving creative problems from physics in the development of thinking, their pedagogical importance is emphasized (B.Izbosarov, T.Rizaev, B.Ibragimov, H.Makhmudova, B. Nurillaev, V.I.Lukashik, A.S.Kondratiev, S.M.Kozel, S.V.Bublikov and others). General approaches to solving such issues have been developed, but the range of functions aimed at developing students' creative thinking as a whole and its individual aspects has not been considered. Ways to create the content of integrative problems and solve creative, non-standard problems for academic lyceums are largely undisclosed. Recommendations for solving certain types of creative problems have been developed in research on heuristic, cognitive issues and their solution (G.S.Altshuller, Yu.S.Murashevsky, etc.). However, this is not enough to meet the growing needs of different educational systems.

In academic lyceums, there is a conflict between the demand for effective methods of organizing the creative activity of students at the level of solving problematic problems from

physics and developing creative abilities, and the insufficient development of theoretical approaches to the methods of designing and solving such problems in physics classes. It is also an important methodological problem to determine the class of such integrative problems that will be effective in terms of developing different aspects of students' creative thinking. The process of solving such problems should be built on an active basis[3].

It is especially important to find ways to increase the creative activity of students in the conditions of reduced study time for studying physics as part of their future profession. Issues of an integrative nature ensure the expansion of the information field, the formation of the skills of applying knowledge in new conditions, the formation of a holistic natural-scientific image of the world in the minds of students, and the development of creative thinking. Our research is dedicated to identifying the features and functions of integrative education in the process of teaching physics in academic lyceums, their solution is aimed at the development of various aspects of students' creative thinking, and the development of methodological recommendations for their design and solution in the physics course. We called such issues, the content of which was built on an integrative basis and were involved in the process of organizing the overall creative activity of the student in a step-by-step, expanded form, as integrative issues, and we set ourselves the following tasks:

1. Analysis of psychological-pedagogical ideas about the essence, components, and factors influencing the development of creative thinking.

2. To study the concept of "learning task", to determine the role of problem solving in the development of students' creative thinking in the process of teaching physics.

3. To determine the psychological, pedagogical and methodological bases of designing and solving integrative issues in the development of students' creative thinking.

4. Determining the role and meaning of the property of integrability in the process of solving physical problems.

5. Determining the content, signs, characteristics of the didactic functions of the class of tasks that provide the most complete and effective organization of creative activity in the process of solving (integrative tasks).

6. Development of guidelines for designing and solving integrative problems.

7. Development of specific options of integrative problems for the physics course of academic lyceums.

8. To determine the impact of solving integrative problems on the development of students' creative abilities.

The following were considered as criteria for the effectiveness of incorporating integrative issues from physics into the educational process:

- the quality of students' knowledge and skills in physics;
- the students' ability to understand the methods of knowledge and cognitive activity in physics;
- positive dynamics of developing students' cognitive interest in physics;
- level of development of students' creative thinking in the process of studying physics;
- the interest of practicing teachers in the proposed methodology;
- readiness of physics teachers to use integrative issues in the educational process.

Our research shows that, on the one hand, solving even a large number of integrative problems cannot fully form students' ability to solve complex problem situations, on the other

hand, solving creative problems in science olympiads often helps to develop creative thinking. but they are not interesting for everyone, because it is a very difficult task to prepare every student from physics to science olympiads. The following problem arises, that is, which classification of creative problems can be used as a means of developing the creative thinking of every student who is interested in learning the methodology of teaching physics.

Our several years of research has shown that physical problems, which are solved step by step, as a whole creative activity in an expanded form, develop creative thinking most effectively.

In order to ensure the process of solving problems in physics in a step-by-step, extended form, it should include all methodological stages of solving problems, in particular: motivation, dividing the problem into some meaningful parts, searching for and choosing a method for solving the problem (setting the goal), modeling a physical phenomenon creation, the process of solving the problem (with mathematical calculations, if necessary), analysis of the results, etc. Let's consider the following example of solving the problem:

Problem solving-1: In the experiment performed in the laboratory lesson (Fig. 1), a ball with a mass of m was released from a height of 3R. (where R is the radius of the slide). With what force does the ball press the lower point of the eraser?[2]

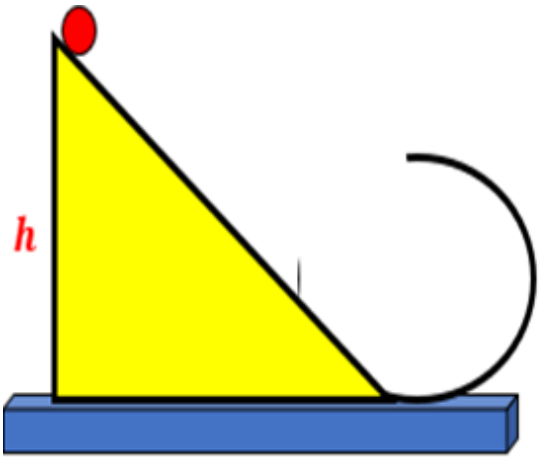

Figure 1

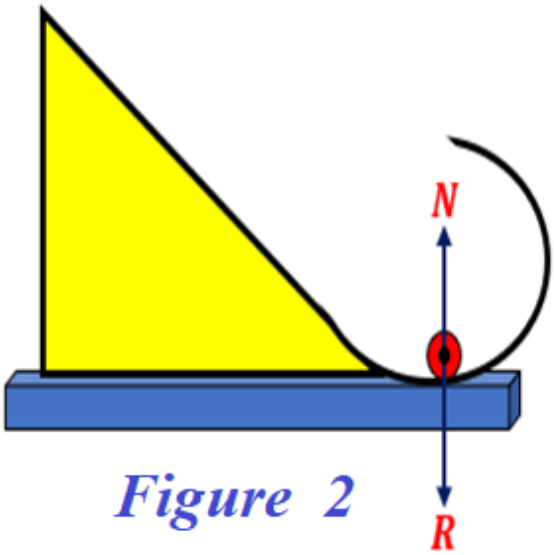

Figure 2

We will use one-to-one analysis and mixed method to solve this problem. By considering the content of the problem, it is determined what forces affect the bottom point of the surface. These forces are the force of gravity **R** and the force of reaction of the support on the sphere **N**. We show in the drawing that the force of gravity is down, and the reaction force of the support is towards the center. (Figure 2). According to Newton's third law, the support acts on the ball with the same force as the ball presses on the support during the movement. So, with the same force that the ball presses on the lower point of the surface, the point affects the ball with the same force in the opposite direction. From this, it follows that the pressure force of the ball on the lower point of the surface is numerically equal to the reaction force of the support, and it is directed downwards. Based on these considerations, we find the reaction force of the support of $\left(\overline{N}\right)$. We know that its numerical value is equal to the pressure force of the ball on the bottom point of the surface. According to Newton's second law for the lower point A of the slide will be $\vec{P}+\vec{N}=m\vec{a}$ (1).

According to the radius, we take the vectors directed towards the center as positive, and the vectors directed away from the center as negative. As a result:

$$-P+N=ma$$

$$N=P+ma$$

$$P=mg;a=\frac{\upsilon^2}{R}$$

$$N=mg+m\frac{\upsilon^2}{R}=m\left(g+\frac{\upsilon^2}{R}\right)$$ will be that.

$$N=m\left(g+\frac{\upsilon^2}{R}\right)$$

Given **m** and **R**, we find the ϑ velocity from the law of conservation of mechanical energy. For the position of the body at the bottom point

$$mgh=\frac{m\vartheta^2}{2}$$ (6) here h=3R equal to, for that will be υ^2= 6gR (7).

Put (7) to (5) equal to N=7 mg. So, the ball presses the lower point of the surface with a force 7 times greater than its own weight.

Let's look at another problem solving:

Problem-2: A wooden cube with sides equal to 10 cm floats on the surface of water. The center of gravity of the cube is 4 cm above the surface of the water. (Fig. 3) What work should be done to submerge the cube in water up to the center of gravity.

When solving a problem, first of all, using the conditions of the problem, we draw a diagram and analyze it thoroughly.

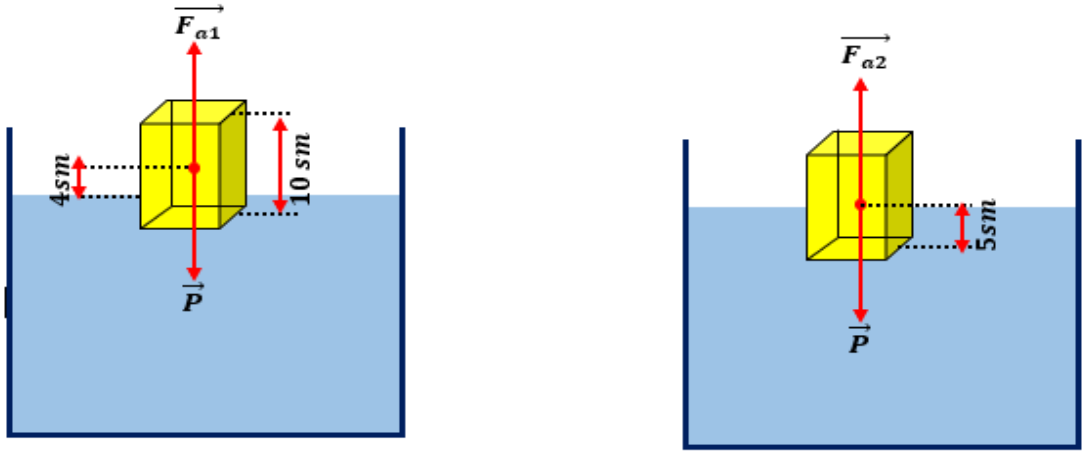

Figure 3

In the first case, while the cube is floating, we apply the floating conditions;

$P=F_{A_1}$ (1)

Equal to $p=mg$,

$$F_{A1} = \rho V \cdot g \quad (2)$$

Here V - the initial volume of the cube in the water (the volume in the water when the cube floats) ρ - water density.

When we immerse the cube in water to a certain depth X, the Archimedean force is greater than the body's gravity. In result F_x force is an equal effector of these two forces and its value is (3) $F_x = F_{A2} - mg$ (3).

Here $F_{A2} = \rho V_1 g;$ V_1 -water density of cube. While we are immersing the cube in water F_x we do work A against the force.

$$F_x = \rho_{21} g - mg = \rho_{21} g - \rho_1 g$$
$$F_x = \rho_2 g - \rho V_1 g \quad (4)$$

From the condition of the problem-solving: $V_1 = Sh_1;$ $V_2 = Sh_2$ $S = a^2;$ $h_1 = \frac{a}{2} - h = 1см$.

So, $F_x = \rho a^2 h_2 g - \rho a^2 h_1 g;$ $h_2 = x + h_1;$ $X = h_2 - h_1$ (5)

$$F_x = \rho a^2 g(h_2 - h_1) = \rho a^2 gX; \qquad F_x = \rho a^2 gX \quad (6)$$

From (6) formula F_x force , X- is proportional to the depth. In problem-solving equal to X=4 sm so, $h = X$. And the average value of the force

$$F_{o'r} = \frac{F_1 + F_2}{2} \quad (7)$$

($F_1 = 0$ $F_2 = \rho a^2 gh$).

So: $A = \frac{\rho a^2 gh^2}{2}$=0,08 J equal to.

In conclusion, the following should be noted:

• In the process of solving integrative problems related to physics and independently acquiring new knowledge, cognitive interests, logical thinking, intuition, intellectual and creative abilities of imagination are developed;

• learns to use elements of mathematical apparatus in solving integrative problems related to physics;

• using equations, systems of equations, ratios, percentages, trigonometric functions, can turn the physical essence of the problem into a mathematical relationship;

• learns to use acquired knowledge and skills in solving practical and life problems.

Solving integrative problems in physics includes the following stages: motivation, search and selection of a solution method (setting a goal), creating a model of a physical phenomenon or process, obtaining results, analyzing and correcting them, as well as reflecting creativity at each stage.

The use of integrative problems and assignments in the process of teaching physics helps to systematize students' knowledge and to form a holistic vision of the world in them. The

effectiveness of the method of formation of creative thinking is taught by the teacher to competently and correctly organize the activities of students in solving problems.

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