РАЗВИТИЕ КРИТИЧЕСКОГО МЫШЛЕНИЯ УЧАЩИХСЯ ПРИ РЕШЕНИИ НЕСТАНДАРТНЫХ ЗАДАЧ

Амандықова М.
Магистрант 2-го курса
Каспийский университет технологий и инжиниринга им. Ш. Есенова
г.Актау
Туркменбаев А.
кандидат педагогических наук, профессор
Каспийский университет технологий и инжиниринга им. Ш. Есенова
г.Актау

DEVELOPING STUDENTS' CRITICAL THINKING IN SOLVING NON-STANDARD PROBLEMS

Amandykova M.,
Master of 2-nd course
Caspian University of technology and engineering named after Sh. Yessenov
s. Aktau
Turkmenbayev A.
candidate of pedagogical science, professor
Caspian University of technology and engineering named after Sh. Yessenov
s. Aktau

Аннотация

Современное общество непрерывно ставит и решает задачи различной степени сложности, постоянно требует новых открытий в технической, культурной, социально-экономической сферах деятельности человека. С развитием науки и техники становится ясно, что научному, культурному, социальному и техническому прогрессу нужны более подготовленные, творческие люди. Таким образом, необходима способность выявлять и решать проблемы, критическое мышление, создавать новые продукты (интеллектуальные, материальные, культурно-эстетические), а также обучать, что, как показывает педагогический опыт, на практике реализуется эвристическими методами обучения.

Abstract

Modern society constantly sets and solves tasks of varying degrees of complexity, constantly requiring new discoveries in the technical, cultural, social and economic spheres of human activity. With the development of science and technology, it becomes clear that scientific, cultural, social and technical progress needs better prepared, creative people. Thus, the ability to identify and solve problems, to think critically, to create new products (intellectual, material, cultural and aesthetic), as well as to teach is needed, which, as pedagogical experience shows, is implemented in practice by heuristic methods of teaching.

Ключевые слова:решения, нестандартные задачи, логическое мышление, творческие задачи,обучение физике,познавательная деятельность, навыки.

Keywords: solutions, non-standard tasks, logical thinking, creative tasks, teaching physics, cognitive activity, skills.

The aim of the article is to reveal the content of students' readiness to develop and form heuristic thinking by solving non-standard tasks in physics lessons.

According to students, the development of heuristic thinking reflects the formation of such heuristic skills as: freedom, critical thinking; imagination, generating ideas, defending one's own opinion and overcoming inertia of thinking, seeing contradictions and problems, applying knowledge and skills to new conditions, developing hypotheses and making valuable judgements.

One of the best ways to develop students' heuristic thinking in physics lessons is to solve non-standard problems, which include the following: with partially incorrect data in the condition; to find the cause of an accident (Why can a person hiding behind a house hear what is happening but cannot see?); of the "black box" type (using the rays coming in and going out of the black box, determine what is hidden inside it); of an investigative nature; whose solution involves implementing the suggested idea (identifying the way to identify the solutions;[1]. Table 1 shows the types of heuristic operations and examples of non-standard tasks which develop it and can be used by teachers in lessons.

Table-1

Unusual tasks in physics

№	The operations of thinking	Problem statement and guidelines for solving the problem
1	induction	There are several identical cogwheels arranged in a plane, the order of which is as follows: the first wheel is coupled to the second, the second to the third and so on. The last wheel is coupled to the first. Will the wheels rotate in such a system? Justify the answer [1]. The drawings of wheels with the directions of rotation indicated on them allow you to establish that the system with 4 and 6 wheels will rotate, the system with 3 or 5 will not. So, on the basis of inductive inference we can conclude: if the number of wheels is paired, the system rotates, if not, it remains stationary
2	analogy	A man is standing at a distance a = 10 m from the river. At a distance b = 50 m from the river, a campfire is burning. The distance between the perpendiculars that connect the rectilinear bank of the river with the man and the fire is l = 80m. A man runs along the bank at a speed v = 5 m/s to the river, scoops up a bucket of water, then runs to the fire and pours it on. What is the minimum time needed for this, if the time of scooping the water and pouring it on the fire is t0 = 8 s [4, p.19]. To solve the problem let's use opto-mechanical analogy. Let's imagine that a source of light is located in the initial position of a man, the boundary between the bank and the river serves as a mirror, and the campfire is a point through which a reflected beam passes. Using provisions of geometrical optics: rectilinearity of light propagation and its reflection law as well as Ferma's principle (light propagates in such a way that it takes the least time to pass through it), we draw and solve the problem
3	symmetry	Two lines intersect at angle α, moving perpendicularly to each other with velocities v and u. Determine the velocity of the intersection point of the lines. Two lines, intersecting each other, consist of a set of points, each moving at velocity v or u, the point lying at the intersection of the lines moves simultaneously at two velocities. It can be determined by the cosine theorem [1, p.9].
4	comparison	Leonardo da Vinci in 1482 posed five questions while investigating the force of friction. Does the sliding friction force depend on: 1) the surface contact area of the bodies; 2) the kind of materials; 3) the force pressing one body against another; 4) the speed of movement of one body on the surface of another; 5) the condition of the surfaces? The scientist answered these questions: 1) no; 2) no 3) yes; 4) no 5) yes. In 1748 the famous mathematician L. Euler gave these answers: 1) no 2) no 3) yes; 4) yes; 5) so. Which scientist was right? [6, c.161] Pupils should experimentally test the hypotheses, compare the results with those of the scientists and draw their own conclusions
5	inversion	A diver is looking out of the water at an object that is almost above his head at a distance of 150 cm from the water. What will the distance from the object in the water appear to him? [3,p. 218] To determine the apparent distance from the object to the water, the system has to be viewed from the side, not from the bottom upwards, as stated in the problem statement
6	specification	A task from Baron Munchausen: "When my favourite horse turns a leg, I usually take the horse on me and we keep going, but slower: when I'm up, our speed is 120 km/h, and when I'm down, it's 30 km/h. What is our average speed if: a) I drive half the way and then carry the horse? b) I drive half the time and then carry the horse?" [5, c. 6]. To solve the problem its condition should be reformulated and unnecessary facts.
7	reduction	Two cylinders with a capacity of 3 l and 7 l are filled respectively with oxygen at 200 kPa and nitrogen at 300 kPa at the same temperature. A mixture of gases at the same temperature is formed in the cylinders after they have been combined. Determine the pressure of the mixture in the cylinders. When solving the problem it is necessary to apply Dalton's law: the pressure of a mixture of gases is equal to the sum of the partial pressures of the constituent gases. Its use makes us divide our problem into two simple ones: 1) the problem with oxygen being in the first cylinder and then in both at the same time; 2) the problem with nitrogen being in the second cylinder and then in both at the same time. In the first and second problem, determine the partial pressure and then determine their algebraic sum.

According to the Kazakh physicist J. Bakinov, solving the above-mentioned types of non-standard tasks developing heuristic thinking of students should be carried out according to the algorithm, adaptation of which to the field of physics knowledge allows highlighting its phases shown in Table-2, and ensures methodologically correct, consistent and natural process of solving non-standard tasks in physics.

Table-2

An algorithm for solving non-standard problems

Decision phase	Actions to be carried out in this phase
Analysing the problem statement of the task	Identify the type of problem (finding the unknown, experimental, evidential, construction, etc.) identifying the parts of the condition; introducing symbols; defining the unknown data; graphing or drawing
Building a problem-solving plan	Comparing the problem to those for which the solution algorithm is known; dividing the problem into several transforming the condition; updating the necessary theoretical knowledge; making a plan for solving the problem
Implementing the plan	Monitoring each step of the decision, checking that it is evidence-based
Study findings results (look back)	Checking the results; finding an alternative way of solving the problem; exploring the possibility of using the results or method of solving other problems The results or method of solution can be used in other tasks.

Thus, heuristic thinking should be the basis for the development of the student's creative potential, and its formation when solving non-standard physics problems should be a teacher's experience.

Analysing physics teaching theory and practice from the point of view of using creative tasks, we can highlight their characteristic significance: they teach children to find their own solutions; have a great influence on the development of inventiveness; break incorrect associations in students' knowledge and skills when making decisions; involve finding new connections in knowledge; promote the search for new links in knowledge formation to master various methods of cognitive activity; create conditions for increasing the depth of knowledge.

As a result, pupils are intellectually stimulated and prepared for active, practical work. Solving logic problems encourages students to think creatively on their own, helps to discover unknown talents, promotes growth, and gives them confidence in themselves and their abilities.

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