

INVENTIVE PROBLEMS AS A MEANS OF DEVELOPING THE CREATIVE ABILITIES OF STUDENTS IN THE EDUCATIONAL PROCESS IN PHYSICS

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SARCINI INVENȚIONALE CA MIJLOC DE DEZVOLTARE A ABILITĂȚILOR CREATIVE ALE ELEVILOR ÎN PROCESUL EDUCAȚIONAL LA FIZICĂ

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Rezumat. Articolul este dedicat problemei dezvoltării abilităților creative ale școlărilor și elevilor în procesul de predare a fizicii. Pe parcursul multor ani de cercetare, autorul a ajuns la concluzia că unul dintre mijloacele care pot contribui la dezvoltarea creativității umane sunt sarcinile inventive. Autorul dă definiția unei probleme inventive. De asemenea, oferă exemple specifice ale formulării și soluționării lor în sala de clasă la fizică. Practica pedagogică a confirmat eficiența utilizării problemelor inventive atât la lecțiile de fizică (la clasă), cât și la munca extrașcolară la această materie academică. Turneul Tinerilor Inventatori și Inovatori, creat la inițiativa autoarei (1998), a meritat o mare apreciere la nivel internațional. Rezolvarea problemelor de către participanții la acest eveniment se încheie adesea cu depunerea cererilor de brevete de invenții. În același timp, se confirmă faptele manifestării creativității școlărilor și elevilor din alte domenii ale activității lor. Articolul va fi util profesorilor de fizică, precum și studenților care intenționează să educe și să instruiască generația tânără.

Cuvinte-cheie. Fizica, învățare, abilități, dezvoltare, sarcini, sarcini inventive, mijloace.

Abstract. The article is devoted to the problem of developing the creative abilities of schoolchildren and students in the process of teaching physics. During many years of research, the author came to the conclusion that one of the means that can contribute to the development of human creativity is inventive problems. The author gives the definition of an inventive problem. It also provides specific examples of their formulation and solution in the classroom in physics.

Pedagogical practice has confirmed the effectiveness of using inventive problems both in physics lessons (in the classroom) and in extracurricular work in this academic subject. The Tournament of Young Inventors and Innovators, created on the initiative of the author (1998), deserved high appraisal at the international level. Problem solving by the participants of this event often ends with the filing of applications for patents for inventions. At the same time, the facts of the manifestation of creativity of schoolchildren and students in other areas of their activity are confirmed.

The article will be useful to teachers and lecturers of physics, as well as students who plan to engage in the training and development of the younger generation of people.

Keywords. Physics, learning, abilities, development, problems, inventive problems, means.

The human psyche is much more complex than any of the computers that exist today, and we are trying to influence it, as if we knew everything about it. At the same time, we often approach the computer not as boldly as we undertake to influence a person in a certain way. I have a moral right to such a statement, because on the second diploma (additional education) I have the specialty of a practical psychologist. I studied not only out of greed for education, but due to the fact that my scientific interests were and remain at the intersection of physics, invention and the psychology of abilities, in particular, the psychology of creativity. This can be seen from the topic of my doctoral dissertation [9].

As you know, the word „creativity” in recent decades is one of the most used by specialists in the field of education. At the same time, quite often it is misunderstood, which not only does not help, but also harms the education system. Let’s imagine that in mathematics one person considers that the sine of the angle of a right triangle is equal to the ratio of the opposite leg to the hypotenuse, and the other under the sine of the same angle considers the ratio of the adjacent leg to the same hypotenuse. It is obvious that the development of trigonometry would have ended with this ... Can we expect the same from a free interpretation of the word „creativity”? In this regard, there is a need for clarification, in the scientific interpretation of those words that will be key in this text.

Let’s start with creativity. The famous psychologist L. S. Vygotsky writes that we call creative activity such human activity that creates something new, no matter whether it is some thing of the external world or a well-known construction of the mind or sensation that lives and manifests itself only in the person himself [6, p.3]. We find similar definitions in other psychologists. It should be noted that in the course of creative activity, a person creates something that has not yet been. Such a new, original product can be a new piece of music, a new painting by an artist, a new poem, a new technical device, for example, a piston and later a ballpoint pen, Grover’s washer, an electric motor, a press for extracting juice from grapes, etc. All that what we use are the results of the creative, inventive activity of people.

According to the author, it would also be appropriate to explain the differences between an invention and a scientific discovery. The explorer discovers what already exists. For example, Ernest Rutherford discovered what an atom and its nucleus consists of, Wilhelm Roentgen discovered x-rays, which were later named after him, Michael Faraday discovered the phenomenon of electromagnetic induction. However, the spring washer mentioned above, which ensures the reliability of the threaded connection, was invented by William Grover, the induction coil (the first transformer) by Heinrich Rumkorff, and the digital camera by Stevie Sasson.

We are talking about a person having specific abilities if he performs certain activities better than others. Abilities, however, develop on the basis of inherited inclinations for a particular type of activity.

Physical education teachers understand that a child who has the inclinations (data) for sprinting is unlikely to show high results in shot put or kettlebell lifting. If only we could borrow such a vision of the problem from them, but teachers and lecturers in the natural sciences for a long time went their own way. They believed that students who achieve success in mastering knowledge are potential creators. It later turned out that this was not the case. The inclinations, and even more so the ability for intellectual activity, manifested in the memorization of a large amount of information and the ability to solve typical problems, do not correlate with the creative process. Moreover, data have been obtained that an excessively high IQ can

even limit a person in creativity. We see this in our own teaching practice. Only a person with developed abilities for this can create an original product.

Both on the process of creativity and on the possibility of developing abilities for it, there are several, moreover, even extreme views among inventors. G. S. Altshuller (literary pseudonym Altov), for example, at first denied the psychological component of human creativity. He argued that technical systems develop without the participation of any human creativity [3,5]. He considered the process of creativity to be an exact science [5]. Over time, he changed his views somewhat [2,4].

It cannot be said that the views on the mechanism of creativity were easily formed among psychologists themselves. However, without going into details, I will note that any abilities develop in the corresponding human activity. And in the educational process in physics, such an activity, as the well-known methodologist-physicist V. G. Razumovsky believed, is the solution of creative problems. This is the focus of his scientific research [11,13] and methodological manuals written for teachers of physics [12,14].

Based on my own pedagogical experience, as well as on the results of my scientific research, I can say that the solution of ready-made, that is, tasks that someone has compiled, is the lowest level of creativity. However, it should not be excluded from the number of means that contribute to the development of human creative abilities.

I do not think that it is necessary to give here the classification of creative tasks that I have proposed. We will focus only on inventive problems. I gave the definition of such a problem in my doctoral dissertation [9]. It is based on the concept of invention.

An invention is a new technical solution of a problem in any branch of the national economy, social and cultural construction or state defense, which has significant differences, which has a positive effect [10, p.45]. For the educational process in physics, it is important that the object of the invention can be a technical device, for example, a device, tool, machine, etc., a method for achieving a positive effect (technology) or the use of a previously known product or method for a new purpose.

It follows that an inventive task should be called such a task, as a result of a technical solution of which a new product or a method of achieving a useful effect appears. The fact that inventive problems cannot have a previously known solution algorithm, as well as the fact that as a result of their solution a new product always appears, allows us to classify them as creative problems [9].

Let's show it on the example of one of such problems.

Problem 1. „Non-stick device”. Quite often, the bottom of the pot, in which soup or porridge is cooked on a gas or electric stove, burns. This happens due to the boiling of the liquid (water or milk). Suggest a device that would signal the liquid boils away or protect the pan from burning.

Quite often, the solution of this problem by students comes down to the creation of various electronic signaling devices with sensors installed in the pan. And now it is no longer considered surprising. Especially with the advent of „Arduino” and many sensors for it.

However, I bring to your attention another solution to this problem (Fig. 1). A pot balanced by a bottle of water will “leave” the flame or electric heating element when a certain amount of liquid boils out of it. The solution is at the level of knowledge of a middle school student. It was made by one of the students of the Krasnosil'ska secondary school of the Borzhniansky district of the Chernihiv oblast (physics teacher Yu. I. Krasnovid).

Here is the answer to the question: „When should we start developing a child’s creative abilities?”. The earlier the better.

And it’s not always worth “attaching” a specific task to a specific topic.

Below are the problems compiled by the author, which were offered for solution to the participants of the All-Ukrainian tournaments of young inventors and innovators.

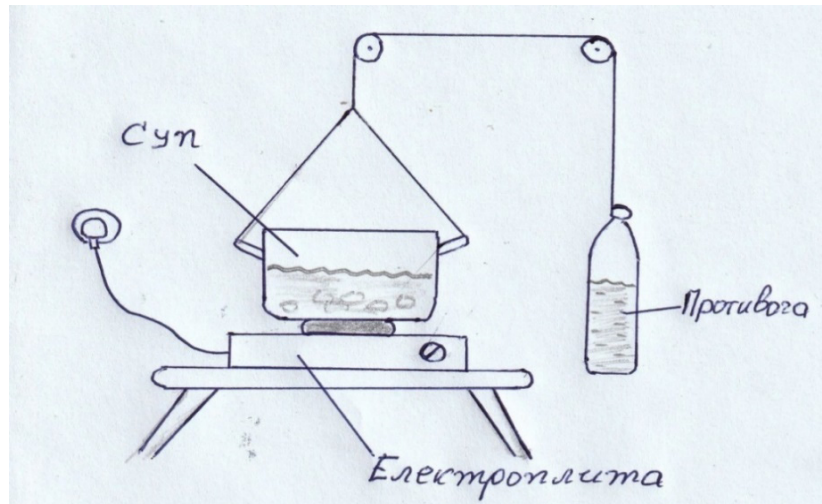


Figura. 1. Device to prevent burning soup

- Problem 2. „Air purifier in the room from dust.”** There are already several options for dust catchers, the principle of which is to pump air through various filters with pumps driven by electricity. Suggest the most simple but original method or a device of a similar purpose that would operate on free energy, that is, at the expense of the premises’ own resource.
- Problem 3. „Preventing the volume of conversation.”** Train passengers are sometimes often disturbed by the loud conversations of people in the next compartment. Offer a technical device that not only signaled that their “conversation” had exceeded a certain volume level, but also made it impossible to continue the conversation in “raised tones”.
- Problem 4. „Titmouse scarer”.** During the wintering of bee colonies in an open place (on the street), certain problems arise. One of them is that hungry tits sit right next to the entrance of the hive and knock with their beak until the guard bees start to come out. Then these birds feast on these insects useful for people. Suggest a device that would prevent tits from disturbing bee colonies and feeding on these insects.
- Problem 5. „Refrigerator from improvised means.”** Mankind knows refrigerators made from available materials and improvised means. Examples of such refrigerators are an ordinary wooden barrel, an earthenware jug, which lower the temperature of the water in them. And among the people there are legends about a frog cooling water ... Suggest your own design of a simple refrigerator that would work at the expense of „free” energy and lower the temperature of bodies by at least 2-3 K.

Problem 6. „Significant efforts.” Technical devices are known that allow a person to create significant efforts: a hydraulic press, hydraulic, pneumatic and mechanical jacks. Propose an original device, for example, a press, which would allow you to create significant efforts (forces) based on other physical phenomena, laws and principles that differ from those already used in the devices mentioned above.

Problem 7. „Efficiency of the light panel”. Recently, people have increasingly begun to use semiconductor light panels to generate electricity. However, their already low efficiency becomes much less if they are installed on glazed balconies of residential buildings (inside the balcony). Suggest how it is possible in this case to increase the efficiency of light panels.

Problem 8. „Rheostat”. An ordinary wired rheostat used in a school physics experiment consists of a heat-resistant drum, on which a wire with high electrical resistivity is wound, and a slider with two contacts. The disadvantage of such a rheostat is that its resistance when changing the position of the slider with contacts does not change smoothly, but abruptly. Propose a wire rheostat, the resistance of which would change smoothly (without jumps). Of course, the dimensions of the new rheostat should not significantly exceed the dimensions of the conventional rheostat and it should be as convenient to use as its „predecessor”.

The All-Ukrainian Tournament of Young Inventors and Innovators was established on my initiative in 1998. This was the introduction of the results of my scientific research on the didactics of physics into pedagogical practice. 23 such events have already been held and for them I have compiled more than 600 inventive problems.

Of course, to develop the creative abilities of pupils and students, they can be used in any type of physics class. At the same time, I do not want to leave unnoticed one more direction of their use. Any of the inventive tasks can be developed into a serious creative STEM project [1,7].

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