Creation of Demonstration Experimental Devices, Methods and Principles of Their Use in the Lecture Process

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ABSTRACT

The creation of demonstration experimental devices when teaching physics in secondary schools, their use in lectures develops the ability to create innovative technologies (startup project) by increasing the intellectual potential of students, teaching students logical thinking.

The main objective of ergonomic research is to increase the efficiency of mental and physical activity of the teacher and student. In the study of physics, physical experiments are of great importance, revealing to students the rich content of science.

Keywords: Ergonomics, technology, innovation, logical thinking, fundamental, national pride, pride, emotional, experience, pedagogical, psychological, didactic, fundamental

Many of the reforms taking place in the education system today are implemented directly in the educational process. Uzbekistan has all the necessary conditions for the transition to a modern model of innovative development. This model is based on the broad and effective use of the created scientific and technical potential, achievements of fundamental and applied science, the introduction of technologies that require deep knowledge, and an increase in the number of highly qualified scientific personnel. While carrying out fundamental reforms and renewal in all areas, we should not forget that these reforms, which will change our way of life in a positive way, will contribute to our spiritual growth and strengthen our national pride, largely depend on mature personnel. National cadres will become one of the main factors in solving problems in these areas in the economic, political and spiritual development of the republic [21]. The contribution of physics, along with other sciences, is significant in this regard. The result of demonstration experiments in physics is the development of students' ability to apply their theoretical knowledge in practice. Natural science is based on the concepts and laws of physics, which occupy a leading place among the natural sciences. In order to form scientific concepts in the physics course, it is important to constantly improve the methodology of teaching students about natural phenomena and enrich the theory being studied on the basis of new technical and scientific achievements. Demonstration experiments in physics play an important auxiliary role, depending on the speaker's logic. It is well known that a well-organized show not only increases the curiosity of the audience, but also develops their imagination. Physical thinking plays an important role in exhibitions, which require a lot of effort and provide high-quality

assimilation of the studied phenomena. An important tool in providing the basis for the development of physics is the student—experiment partnership, and ergonomics is the link that provides prospects, features and, finally, broad opportunities for science. Ergonomics is studied in order to coordinate the student's work as much as possible with the experience in which it helps in work.

Ergonomics — (Greek ergos — work and nomos-law) means "work and law". It has been widely used since the twentieth century as a generalization of the mechanical functions of human activity and as a coherent system of a number of disciplines, such as psychology, physiology, hygiene, economics. The International Ergonomic Union was founded in 1969 and has more than 30 countries, whose congresses are held every three years. Their official journals Ergonomics, Applied Ergonomics and Ergonomics Abstracts were published, and ergonomics specialists were trained at universities in several major countries. Scientific research conducted in the Commonwealth of Independent States has been applied in many organizations. Since 1960, an information booklet "Technical Aesthetics" has been published monthly, and one of the scientific studies in various fields is pedagogical ergonomics [18, 19, 20].

The main objective of the research of pedagogical ergonomics is to increase the efficiency of the mental labor activity of the teacher and student. It is well known that the experience of studying physics is of great psychological importance, and also reveals to students the rich content and high qualities of science. Tasks that unite and regulate the reader and experience that have become topical are called ergotics.

When introducing pedagogical ergonomics in education, attention is paid to didactic, technical, psychological-physiological, artistic-constructive and economic requirements, as well as hygienic, anthropometric, physiological and aesthetic issues affecting the creation of demonstration experiments of mental labor.

The results of this study are reflected in the journal "Problems of Education" [17], as well as in the improvement of physical education based on demonstration experiments [15]. The task of improving the content of demonstration experiments in physics and methods of their organization is one of the central issues awaiting solution in the methodology of teaching physics. Much attention is paid to the quality of training in higher education. The role of physical experience is invaluable in training a physics teacher with a high level of knowledge and professional skills.

In the lecture practice, much attention was paid to the use of modern scientific research and technical means. The experiments were developed based on the requirements of pedagogical ergonomics [21]. The book edited by V.P. Zinchenko [2] discusses the issues of access to ergonomics. The Encyclopedic Dictionary of Physics is devoted to ergonomics and its analysis. The encyclopedia explains the term ergonomics extensively.

The concepts and laws of physics underlie the natural sciences and play a leading role in their connection with the social sciences. Practical activity in physics is not free from theoretical thinking and corresponding hypotheses. Theoretical knowledge is based on practice, not on experience, and plays the same role in the educational process as in scientific research. At the initial stage, this is the activation of the cognitive activity of the student, which contributes to obtaining solid knowledge in the future. The psychological state plays an important role in the in-depth methodological study of sources, ensures that students maintain a high level of knowledge for a long time and has a positive effect on the speed of assimilation of knowledge, volume, memorization of educational material. It is well known that visual aids and demonstration experiments play an important role in the psychological education of students. As M. writes Kurbanov, "the depiction of physical phenomena without taking them away from life allows the reader to draw an unmistakable connection between theory and practice and avoid some difficulties arising in them through the description of the event" [5].

An important aspect of the exhibition for pedagogy is its naturalness and rapid perception of subjects by students. At this stage of the educational process, the exposition is

selected depending on the level of assimilation of the educational material. The experience of physical demonstration at a lecture, the choice of a lecturer in accordance with the topic will be an important factor in a deeper study of the topic by each student. Demonstration experience, if well demonstrated, encourages students to communicate and increases their curiosity. It affects not only the activity of thinking, but also the emotional side, imagination. The educational materials related to such demonstration experiments are well understood. Psychological experiments show that the experience of demonstration leaves a deep impression on the reader. It follows from this that demonstration experiments at lectures for students are an element of their professional training.

During the lecture, if the learning goals are formed based on the needs for acquiring knowledge, skills and abilities, the goals of cognitive activity will be broader and richer in content. The learning process by introducing methods used in science into the educational process, teaching students the techniques of mental activity - analysis - synthesis, comparison, abstraction, generalization, inductive and deductive reasoning, the formation of students' skills of independent work on methodological manuals and other teaching aids slightly reduces the differences between the learning process and the learning process. The presentation should be carried out in such a way that the interaction of theory and practice is on the same level, and students are informed about the laws of physics, otherwise, with a deep approach to history, students may come to the conclusion that "Everything happened in the past." Therefore, it is necessary to mention new achievements in physics, their research and development. Lecture experience is useful here, i.e. a well-chosen experience shows how difficult it is to uncover certain events. At the same time, achievements of science and technology, prospects for the development of research can be used in the presentation. In this regard, there are many methodological centers abroad where teaching is based on historical approaches.

We divide the demonstration of the importance of experimental devices into the "experiment and reader" system in the presentation of the physics lecture. The quality of functioning of this system depends on the fact that its elements are compatible with each other, the properties of devices and the problem of active coordination, technical means and features and capabilities of the student's body, studying a new scientific independent science – pedagogical ergonomics. The control object combining technical devices with a reader is technical devices, and the function of regulating devices is called ergotic devices. An example of such a system is the transfer of several demonstration experiments to students from one device, and the object of control in one or another section is the devices of physical demonstration experiments used at the lecture. Ergonomics studies the main features of the teacher's work in order to maximize the coordination of the design of devices and mechanisms with him.

Without psychological capabilities, knowledge and human hygiene requirements, it is impossible to create spacecraft, high-noise aircraft, high-precision equipment. Ergonomics also takes into account the artistic design of the devices.

The main objective of ergonomic research is to increase the effectiveness of the mental work of the teacher and student. The main indicators of theoretical work that affect practice include:

- hygienic (room width, light, color, peace, cleanliness, etc.);
- anthropometric (in the process of demonstration experiments, the correspondence of the student's body to the object of the experiment and the description of movement, tension and force);
- physiological and psychological - physiological (speed of reception, comprehension and processing of information);
- aesthetic (requirements for the artistic design of experimental devices).

In the system that we see, the role of the manager is significant, he is the central control link of the ergotic system, on the other hand, speaking, asking specific questions and theoretically solving it together with students and finally justifying the conclusions obtained

through experience. Unfortunately, little attention is paid to the principles of ergonomics when developing demonstration experiments that should be presented during the presentation. Many demonstrations of physics are due to the low efficiency of experiments, lack of consideration of psychophysiological representations of students.

From what follows, it can be learned that the demonstration experimental devices of the main link meet all the requirements, i.e. the principles of ergonomics demonstrated in ergotics.

Didactic principles are a requirement that includes the following basic theoretical principles of teaching:

1. The need to identify basic and general concepts using demonstration experimental devices used to explain the event.
2. A simple and understandable presentation of experimental demonstration drawings that reveal the essence of the phenomenon. These requirements are inextricably linked with a high level of disclosure of the phenomenon of understanding and observing experience. The simpler the experimental device looks during the demonstration, the more convincing it will be.
3. The correspondence of the time of the demonstration of the experience to the description of the event.

Technical principles

1. The versatility of demonstrative experiments, i.e. the use of equipment for various experiments used in one experiment. The demonstration experience should be as accurate as possible, since the work consists of a large number of parts, otherwise such multifunctional sets will not give good results and will lead to an unnecessary waste of lecture time.
2. The structure of the demonstration experimental device allows experiments to be carried out without additions and adjustments, such a design of the device reduces the presentation time.
3. Experimental device - using the most optimal method when changing the initial state of the equipment.
4. Consistency in work.
5. Ease and simplicity of application technique and technology.
6. The ability to easily change the length of the base of the display table.
7. Safety at work.

Psychological and physiological principles

1. The placement of demonstration experimental devices should be such that all structural elements are visible at the same time.
2. Demonstration experimental installations should be located in a convenient position for use and demonstration.
3. The devices should be positioned so that their total length is about one meter, which allows them to withstand anthropometric conditions.
4. Auxiliary device - equipment (power supply, generators, etc.) cannot be in the field of view of students: all control knobs should be located at a height of 1 m from the ground, but should be easily demonstrated during the lecture.
5. It should be possible to quickly assemble the device from the field of view of students.

Artistic and constructive principles

1. Device design.
2. Selection of the material.

It should be borne in mind that the demonstration, the artistic and constructive structure of experimental devices and their compliance with technical, aesthetic principles in many ways allow for the design of the experiment.

Economic principles

1. The versatility of the devices.
2. Economic requirements often contradict technical requirements and, in our opinion, are not decisive.

The possibilities of following the principles of ergonomics when using demonstration experiments in the lecture process are as follows. The effective use of demonstration experiments in terms of the development of students' thinking abilities in the process of teaching physics creates various conditions for creativity. We know that demonstration experiments play a leading role in the practical verification of the correctness of theoretical conclusions. The nature of the demonstration experiments used varies, and it is desirable that the method of choice depends on the

pedagogical skills of the teacher and includes ergonomic aspects.

In this regard, following the principles of pedagogical ergonomics of demonstration experiments, we will consider the following multifunctional sections "Transformer device" and "Ultrahigh frequency generator device", "Tesla Transformer", "Generator of inextinguishable vibrations", "Resonator for inextinguishable vibrations", as well as "Optics". The fact is that multifunctional demonstration experiments are considered using a device that demonstrates a demonstration experience by adding quite small additions to it.

It is known from electrostatics and electromagnetism that a multifunctional high-frequency generator device creates an electric field in space around a stationary electric charge, while the magnetic field exists only around moving charges. The lines of force of such an electric field consist of open lines of force starting with a positive charge and ending with a negative charge.

The process of propagation of alternating magnetic and electric fields is an electromagnetic wave. During the propagation of electromagnetic waves, changes in electric and magnetic fields occur periodically at each point in space. When generating electric and magnetic fields alternating in time, an inertial magnetic field or an inverse electric field occurs, respectively. If an electromagnetic field is generated in a finite region of space, this field propagates to the rest of space at a finite velocity. This speed is very high, equal to the speed of light in space ($3 \cdot 10^8$ m/sec). When the generated electromagnetic field has a periodic character, it propagates in the form of a wave.

The propagation of an electromagnetic field in the form of a wave follows from the general theory of electromagnetic phenomena created by Maxwell in 1863, that is, a rotating electric field is formed in space around an alternating magnetic field. Electromagnetic waves were first experimentally studied in 1888 by Hertz. Hertz investigated the phenomena of rotation, refraction, interference, diffraction, etc. of electromagnetic waves and determined that all the laws of optics are applicable to electromagnetic waves. As a result, Maxwell's theory of electromagnetic waves was confirmed, and he laid the foundations for the practical generation of electromagnetic waves of various lengths [6, 7, 8].

Based on Hertz's experiments , the following properties of electromagnetic waves were determined:

1. Like light waves, electromagnetic waves are absorbed and scattered in matter.
2. The electromagnetic wave returns at the same angle at which it falls on the metal surface.
3. When an electromagnetic wave falls on the boundary of two media, it is refracted in the same way as a ray of light.
4. Since the electric field strength of the electromagnetic field and the magnetic field induction vectors are perpendicular to the direction of wave propagation, electromagnetic waves are transverse waves.
5. Electromagnetic waves are polarized in a very high frequency generator, i.e. they are generated in the form of waves whose oscillation amplitudes are located in a certain plane.
6. In electromagnetic waves, as in light waves, one can observe important phenomena consisting of interference, diffraction and dispersion.

Modern radio equipment allows for very precise experiments to observe the properties of electromagnetic waves. In these experiments, the most optimal use of centimeter-range waves emitted by special ultrahigh frequency generators.

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