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Advanced Pedagogical Technologies of Teaching Physics in Medical Universities

1. **Yunusova Rano Gaybilloyevna**

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[1] Assistant of Bukhara State Medical Institute, yunusova-2121@mail.ru

Abstract: The use of modern educational technologies in the education of natural sciences is one of the urgent methodological problems. This article examines innovative technologies based on the use of information and communication technologies in education. Methodological possibilities and perspectives of their use in the educational process of physics are shown. Advantages and disadvantages of integrating modern educational technologies in physics teaching are noted. The basis of the article is the pedagogical experience using computer educational technologies in teaching physics in medical universities. Modern educational technologies open up new opportunities for organizing physics teaching, information exchange and increasing its efficiency.

Key words: pedagogical technologies, physics, medical universities, students, "Face-to-face" method, teaching strategies and etc.

Physics is one of the subjects studied at school, usually school subjects at different levels ranks first in terms of difficulty. In addition, this is why the general knowledge skills and abilities of students are low. The physics teacher faces the following problems. Pupils were in science how to increase students' interest in science interest should not depend on the situation and part of their professional life what to do to turn. A systematic solution to such problems is a "successful situation" for students. it is necessary to present it, so that students can achieve success. One of the methods is the introduction of modern pedagogical technologies is to develop students' creative abilities.

To successfully master modern methods of diagnosing and treating diseases, graduates of medical universities urgently need basic knowledge in the natural sciences. Among natural Sciences today an important role is played by physics, mathematics and related technical disciplines: medical electronics, medical technology, materials science, energy saving, etc. [1]. Nobel laureate for physiology, Russian and Soviet scientist, academician I.P. Pavlov, at one time noted that a deep understanding of the vital processes occurring in the human body requires knowledge of the laws of physics and other natural sciences. Since the time of IP Pavlov, much has changed both in physics itself and in medicine. Today, progress in the field of diagnosing diseases is associated not only with ultrasound, X-ray studies, but also with electron and atomic force microscopy, paramagnetic and nuclear magnetic resonances, computed tomography, etc. Many therapeutic methods are based on the use of magnetic, electrical fields and radiation. Specialist with a higher medical education, applying in practice modern methods of diagnosis and treatment, must have a clear understanding of the laws of physics underlying them. It is also worth noting that the evidence-based bias in medicine and health care adopted in recent years all over the world, requires a specialist with a higher medical education to possess a modern arsenal quantitative mathematical description of biomedical data, the ability to give a mathematical justification any method of treatment or diagnosis. Students of medical universities receive the basis of knowledge in this area by studying the basics of probability theory, mathematical statistics and elements of higher mathematics, which are included in the classical courses of medical and biological physics. Modern tools for teaching physics in general educational institutions far from the most effective and interesting things for students. Currently available existing teaching methods are boring and do not attract students' interest. Current students rewrite the same information at their desks for the entire school year they don't want to spend.

In addition, the importance of the disciplines of the physical and mathematical cycle taught at a medical university lies in the fact that these disciplines contribute to the development of correct, logical, causal medical thinking, which takes into account the physical and chemical nature of all phenomena occurring in a living organism. The term “blended learning” (Blended Learning) was introduced into pedagogical practice by Bonk and Graham, who published the Handbook of Blended Learning in 2006. Initially, hybrid training was used as a method for the training and retraining of professional personnel. for companies. Since 2008, hybrid technologies have been used in higher education. In higher education in the Republic of Belarus, this approach has been used and studied relatively recently and has several equivalent names: hybrid, synthetic, integrated education. To date, under hybrid learning refers to the synthesis of traditional forms of learning with distance learning methods. Hybrid learning, as you know, is three-component: a) learning in the classroom (Face-to-Face Learning); b) distance learning (Distance Learning); c) self-study learning. Currently, hybrid learning is one of the trends in modern education and, according to experts, will remain so in the next decade. By creating labs, students will have many new tools for self-discovery, creating new projects, and learning school materials. Entering the walls of the laboratory, students feel not only students, but also scientists who have to solve any assigned and responsible tasks. Modern means of teaching theoretical and practical courses of physics in general educational institutions cannot provide the material and technical base that previously announced laboratories can provide. Modern classrooms are equipped with almost nothing except desks and wall boards. Pupils are not allowed to do the same thing, to conduct training in the same conditions every day. Modern students need a change of scene, new and innovative solutions are required for learning physics. A modern equipped laboratory will be the best of all possible innovative solutions to attract attention and desire to the educational process of today's students.

At present, when the e-Learning model is still imperfect when teaching natural sciences in medical universities of the “digital” generation of students (the so-called z-generation), and traditional technologies today look archaic and not relevant enough, it is very effective Blended learning model. Of the several well-known forms of hybrid learning, we use the so-called “Rotation” model in the disciplines of the physical and mathematical cycle. According to this model, educational time is distributed between individual online learning and collective learning in the classroom under the guidance of a teacher. The specific implementation of the “Rotation” model is such that students in the classroom together with the teacher, they analyze the theoretical material, work with methodological instructions for the lesson, receive general instructions and advice from the teacher on the implementation of practical assignments. Remotely in the Moodle environment, students pass the current control of knowledge on theory (Moodle lectures and Moodle tests), perform laboratory work, participate in thematic forums and surveys, receive reviews of completed work and, if necessary, receive online consultations from the course instructor. It is important that intermediate and final control is carried out in the traditional face-to-face form ("face to face"). The presence of Face-To-Face learning elements in hybrid methods contributes to the ability to discuss, defend one's views, present one's ideas, present and defend one's projects, etc.

There are many obstacles to studying physics. We are talking about overcoming the patterns and habits associated with outdated textbooks for the general physics course, about the need to improve the qualifications of teachers, about expanding the cognitive capabilities of students and deepening their knowledge, about overcoming difficulties in their assimilation of the concepts and laws of modern physics. Unfortunately, sometimes schoolchildren have difficulty in assimilating many complex physical concepts and phenomena. But these difficulties indicate that the modern structure of the lesson and the teaching methods used do not provide the necessary mental activity of students. Therefore, it is necessary to look for ways of a qualitatively better organization of the educational process and more effective methods of teaching physics. It is necessary to activate the cognitive activity of schoolchildren in the classroom, to create conditions under which the student would not only listen and think, but also do something, translate thoughts into deeds. It is necessary to involve students in the classroom to work on a textbook, to perform frontal physical experiments, to solve creative tasks, qualitative and numerical problems. Thus, the main reserve in improving the quality of education is to improve the methods of conducting classes. But at the same time, do not forget to correlate with each other:

- motives of learning activities and awakening interest in the material being taught;
- clear understanding by the student and the teacher of the tasks and requirements for the learning outcomes for the development of competencies;
- disclosing the content of the lesson in accordance with the methodological concept, equipping students with the methods of science, general approaches to the studied material, taking into account the tendencies of the development of physics;
- systematization and generalization of educational material, consolidating it through exercises and independent work with a textbook or synopsis;
- Checking and assessing knowledge, as well as the level of educational activity of schoolchildren in the lesson.

All this provides the use of interactive learning tools. For example, libraries of electronic visualizations provide the ability to visualize complex physical phenomena and processes, their internal structure and features of their course. The didactic value of means of this type is determined by their capabilities in the formation of complex skills of students to describe and analyze physical phenomena, processes and laws, to draw generalizations and conclusions. The use of libraries of electronic visualization acquires particular relevance when explaining physical phenomena that are difficult to recreate in a school physics laboratory, as well as in conditions of insufficient equipment in a school physics classroom. Virtual physics laboratories are designed to improve the methodology for the formation of practical and experimental skills and abilities of students of a comprehensive school in physics. The virtual laboratory includes separate subsystems: computer laboratory work, video support of the process of performing laboratory work in a school physics laboratory, an information subsystem, a "gallery of devices" subsystem, a subsystem for consolidating knowledge and skills. Experiments are especially interesting Tof G.N. Zainasheva and S.F. Malatsion, who developed educational technology for teaching physics. The conceptual basis of the proposed author's technology is a competent approach to learning, which involves the formation of general educational skills and abilities, universal methods of activity and key competencies.

The content of the technology is the content of the program in general physics and the goals: mastering knowledge in physics as a basis for professional knowledge; mastering skills; application of knowledge to explain natural phenomena; development of cognitive interests and creativity; education and development of the student's personality as a future representative of the technical intelligentsia; using the acquired knowledge and skills to solve practical problems, etc. The organization of the educational process includes: lectures, practical exercises in problem solving and laboratory exercises. The teaching method is based on the theory of reflection: in knowledge, students see an objective reflection of the external world; cognition of both objects and phenomena of the external world is carried out by revealing their connections and development; the assimilation of laws and theories is combined with active practical activity, the acquisition of practical skills and abilities, as well as their application. Methods and forms of the teacher's work: problem-research presentation of lecture material with the active participation of students, their systematic work on homework for lectures, lectures - discussions, solving physical problems of various levels of complexity, multilevel training in practical classes, control testing at the beginning and end of the studied sections of the course, the use of information technology. The presented pedagogical technology can be used when conducting lectures, practical and laboratory classes for schoolchildren, which will contribute to the formation of general educational and professional competencies in future specialists. Of course, the majority of physicists have been engaged in the development of physics for many decades as the fundamental basis of modern natural science. Gradually, physics, in addition to this, began to more and more solve the problems of applying physical laws, processes, means and technologies to various areas of human activity, primarily to technology and weapons. Today the situation has changed, and physics is shifting its priorities towards peaceful purposes, including healthcare. Currently, traditional medicine is increasingly turning into physical medicine, equipped with the most complex, expensive and at the same time very effective medical and physical complexes and technologies. The main feature of modern medicine is its high physical and technical equipment. At the same time, the most important weapons of physicians in the fight against diseases are precisely various medical and physical technologies of the highest level and radiological devices for diagnostic and therapeutic purposes, which greatly increase the possibilities of medicine. At present, it is difficult to imagine any problem of prevention, diagnosis or treatment, where the achievements of physics, primarily the physics of ionizing radiation, would not be used, and medical radiology is entirely based on the achievements of modern medical physics.

The most important condition that contributes to the formation of these qualities of the personality of future specialists is the construction of the educational process on the basis of the widespread introduction of problem and heuristic training, through a system for finding solutions by students of educational and practical problems. In our opinion, the implementation of the principle of linking education with practical activity is possible in the process of teaching practical physics at the main graduating departments of the university (biophysics, radiology, radiation medicine, etc.). Unfortunately, the curricula in these disciplines, even if they contain physical sections, are not sufficiently developed. In our opinion, the most justified is either the creation of optional physics courses in the most relevant areas of medicine for 5-6 year students or even short cycles in practical physics for graduating departments with the involvement of physics teachers. The most important aspect of modern teaching is an adequate system for assessing student knowledge. We believe that the point-rating (credit-modular) system used at the departments is most conducive to stimulating and improving the quality of students' educational activities. Teaching a future specialist to independently acquire and constantly deepen his knowledge, to form persistent cognitive motives and the ability to quickly navigate in the rapid flow of scientific information is one of the main tasks of modern education. Self-education and self-study should become two interrelated aspects of the pedagogical process.

An attempt by someone who is concerned with postgraduate education to evaluate the present teaching of the basic sciences to first M.B. students is beset with difficulties. While it is true that one should be in a position to judge how well the students from a number of different schools and from several parts of the world have been equipped scientifically for the work they have to do as doctors, one is also out of touch with the trend of thought in the undergraduate schools and with the plans for improvement in the training that are already afoot. What appear to be defects may be reasonable compromises hammered out after long discussion, and what seem to be obvious overdue reforms may only be awaiting the moment when they are no longer quite impracticable. Voluntarily to undertake the task of teaching one's grandmother how to the physical principles involved in extracting the contents of eggs is extremely rash. The incentive is a firm belief in the need for more science in medicine. By this I mean a way of thought, an approach to problems, and not merely what appears to the lay; public so often as a rather terrifying and uncontrollable technology. The process of development of medicine from a mediaeval art into a modern science is proceeding. There is no knowing where important implications to medicine may appear at any time from advances in the basic sciences. The study of mechanics led the anatomists to advance their interest in form to include an interest in function. An obscure draper in Delft, through a persigtent interest in lens-grinding, was the first to see an animal " a thousand times smaller than the eye of a large louse" in a drop of water, and so laid the foundations of bacteriology and histology. As in the past so to-day: the introduction of artificial radioactivity in providing a new method of investigation by tracer techniques has started a new era of medical research.

The reason for inviting a radiotherapist to write about the teaching of physics is presumably that radiotherapists are so clearly concerned with the application of physics in medicine, and that they have been foremost in recognizing the need for the appointment of hospital physicists. Radiotherapists are not, however, alone in their interest in medical physics, the place of which is hardly given adequate recognition by astonishing statements such as the following which appeared in a leading article in the British Medical Journal in 1945: " At present the application of physics to medicine is limited to radiology, the electrocardiograph, and the encephalograph in diagnosis, and the somewhat empirical use of various forms of radiant energy in treatment; but it is highly unlikely that these represent more than a fraction of the contribution physics might make to human biology."

The importance of physics in medicine and the fact that the teaching of first-year students has been unable to keep pace with the advances cannot be seriously disputed. Before we judge the success or failure of present methods of instruction, however, we must have a clear understanding of what we want to achieve. It is all too easy to point out how much more is required, and all too difficult to reconcile the claims of the many subjects which compete for time on the already overloaded medical curriculum. If every sectional interest had its way years might be added to the training of the poor medical student, who only wants to be a doctor. The reason for teaching him physics should be to help to make him a good doctor first and to provide him with an appreciation of the practical applications of physics in medicine second. We should not forget, in considering the first, that technical ability may be an important professional quality and, in considering the second, that so many branches of medicine are open to each individual student that he is unlikely to deal personally in practice with more than a small fraction of the physical methods concerned. Teaching that does not help the student towards these ends should be ruthlessly eliminated on the grounds that the inclusion of any unnecessary work under the present conditions of strain in a medical education amounts to cruelty. Anyone in daily association with a large and active department of medical physics employing nine physicists may be forgiven for stressing the importance of the practical application of physics in medicine, but no one who also consults with a number of doctors about the treatment of patients with cancer could deny the paramount importance of a sound general scientific education. The advancement of the practice of medicine demands that doctors receive a thorough training in the scientific method of logical, objective, dispassionate thought. To teach a medical student that the field of human knowledge is expanded by reason and experiment; that he should remain unmoved by plausible argument while retaining the capacity to accept new ideas, and so depend upon his own judgment; that when his facts are verified and his arguments tested he should proceed to apply his conclusions fearlessly-this is an achievement which rises far above the mere provision of technical proficiency.

Those combinations of qualities which go to make a good doctor and which are so hard to define are enriched and given purpose by a scientific outlook. The dissection of a problem to its fundamentals, the correlation and interpretation of the available facts, the conclusion uninfluenced by personal bias, add point both to the skill with which he applies his treatment and to the understanding and fellow-feeling that soften his conversation with his patients. We have too many fashions in medicine, too many new remedies which work wonders for a while, too many specialists whose diagnoses always lie within their specialty, and too many medical advocates of quack " cures" on the basis of one or two cases unusual in their limited experience but well within the bounds of normal variation. It is reported (Shryock, 1948) as an example of the sad way in which treatment used to be based on mere assertions of the most dogmatic sort that Freteau, in the early nineteenth century, insisted on the necessity for venesection in certain conditions " on the ground of two reported cases, each susceptible of other interpretations than those he accepted" (the italics are not mine). Why pick on the nineteenth century when 1949 would do as well? We do not have to go so very far back in the correspondence columns of our medical journals for equally good examples. Doctors are not always less susceptible to convenient illusions than their fellows, nor are they less ready to produce rationalizations to preserve for themselves their appearance of reasoned thought and logical action. The laudable desire to save the medical student from some of the rigour of the syllabus, to get down to "the fundamentals of medicine" and away from all this " pure physics," must not be allowed to interfere with his essential, basic scientific education. Physics and mathematics are particularly valuable as a background training in scientific thought and method.

Having insisted on physics for its basic educational value, must we therefore necessarily insist on a course of classical physics similar to that planned for the elementary training of physicists? Surely a greater concentration on medical physics will serve our purpose just as well and at the same time add interest and practical advantage. The undergraduate should learn to appreciate the use of physical methods in medicine and acquire a basic knowledge on which to build should he later take up some branch which is closely associated with a particular form of medical physics. It may be as well that the basic sciences should not seem to be too well defined; medicine has no interest in artificial barriers between the sciences, and physical chemistry and biophysics cannot be ignored because they have been arbitrarily placed on some borderline. We shafl certainly not solve the real problems of the lengthening syllabus, the urge to get on with the things that will be useful, and the need to eliminate the inessential by insisting on the status quo. Once the student has embarked on his medical career the continuation of his scientific education should surely be made an integral part of his training rather than a preliminary to it. The medical student sets out to do medicine; he regards a good deal of what he is taught in his preclinical course as being divorced from this object. It is too often merely an obstacle in the path of his progress towards matters of real interest. He has to-day to overcome considerable difficulties to be allowed the opportunity to start at all, and at this stage is eager for instruction in subjects that seem to him to have an obvious medical application. When you start out to heal the sick it is a little discouraging to find yourself confronted by a Wheatstone bridge and a post-office box. Modern laboratories in the material and technical base of the existing physics rooms of educational institutions allow students to directly participate in performing, calculating, experimenting, solving, and observing physical phenomena and tasks. None of the existing physics classes have this. Therefore, this idea can be called unique and innovative in solving the issue of teaching the school physics course.

The practical utilitarian side of the instruction appears shyly here and there in the syllabus with the mention of osmosis, spectacles, microscopes, ophthalmoscopes, radioactivity, and thermionic emission. That no real importance is attached to these concessions to those who have demanded more direct application of the prescribed syllabus to medicine is shown in the list of exemptions which allows a boy from school to avoid all such instruction. The introductory paragraph of the syllabus of the University of London for " Physics (including Mechanics) " does not say, "The subject is to be treated as a basis for the development of a critical, reasoning, scientific outlook and illustrated as frequently as possible by means of direct practical examples of the applications of physics in medicine; a knowledge of mathematics on the part of the student is an inestimable advantage in attaining this object, the experimental approach being the only other method likely to be successful." Instead there appears the rather dreary sentence, "'The whole subject is to be treated in an elementary manner, the mathematical development in no case extending beyond a knowledge of quadratic equations and elementary trigonometry." It has been suggested that the first M.B. might be abolished and that instruction in chemistry, physics, and biology be given along with that in anatomy and physiology in one preclinical course. More time is wanted for the second M.B., and it is thought to gain it at the expense of the first. The time would presumably be gained by the elimination of much of what is now taught in the basic sciences and regarded by some as unnecessary, and what remained would be more closely related to practical, everyday medical needs. If every student received a sound scientific training at school, if anatomy and physiology were not allowed to swamp the chemistry, physics, and biology that remained, and if teaching were done imaginatively and largely by the experimental method, using direct clinical applications for illustration, there would be much to be said for the suggestion. The student would start off doing something more nearly related to medicine; he might better appreciate the need for the physics he was being taught. There are, however, a lot of " ifs " concerned. I do not know how such an arrangement would work, but while fundamental changes are being discussed there are still reforms which surely should be made at once.

In conclusion, thus, the identification of the conditions for innovative learning allows us to determine the mechanism for the formation of an information and educational environment that ensures high efficiency of the results of educational activities. An important trend in innovative teaching physics is the acquaintance of students with the methods of obtaining scientific knowledge, with the methodology of mathematical modeling, the features of the integration of science and education, the inclusion of all students in the active process of formation of knowledge and generalized ways of activity due to the skillful creation and management of the emotional field, with the maximum use of reserves internal motivation of students.

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