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Innovative approach to teacher development physics and astronomy

Mikolay Makarovsky, Olena Savchenko, Volodymir Zakhozhay, Mariia Tertyshna

Department of Physics, V.N. Karazin Kharkov National University, Svoboda Sq. 4, Kharkov, Ukraine, 61022

ORCID: 0000-0001-6235-8217

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The article discloses a new program for advanced training of teachers of physics and astronomy at the Karazin Kharkiv National University. The main attention is paid to the content and features of the "professional bloc". Attention is drawn to the peculiarities of the teaching of physics and astronomy in modern conditions and the role of fundamental discoveries in shaping the formation of the schoolchildren views.

Keywords: physics, innovative methods, training of physics and astronomy.

М.О. Макаровський, О.М. Савченко, В.А. Захожай, М.В. Тертишна

У статті обговорюється нова програма підвищення кваліфікації вчителів фізики та астрономії в Харківському національному університеті імені В. Н. Каразіна. Основну увагу приділено змісту і особливостям «професійної блоку». Звертається увага на особливості викладання фізики та астрономії в сучасних умовах і роль фундаментальних відкриттів на формування наукового світогляду у школярів.

Ключові слова: фізика, інноваційні методики, підготовка вчителів фізики та астрономії.

Н.О. Макаровский, Е.М. Савченко, В.А. Захожай, М.В. Тертишная

В статье обсуждается новая программа повышения квалификации учителей физики и астрономии в Харьковском национальном университете имени В.Н. Каразина. Основное внимание уделено содержанию и особенностям «профессионального блока». Обращается внимание на особенности преподавания физики и астрономии в современных условиях и роль фундаментальных открытий на формирование научного мировоззрения у школьников.

Ключевые слова: физика, инновационные методики, подготовка вчитилив физики и астрономии

Achievement of physics as a science is mainly determined by the substantial character of the world's scientific picture. It presupposes the important role of physics in the programs of all educational institutions, starting from general schools and finishing with the classic universities. The reconstruction of Ukrainian education system, reflected in the new laws ("About higher education", "About education", etc) requires making changes both in the current content of an academic program and teaching methodology. Despite the appearance of the distant form of studying, internet-lectures of well-known specialists, development of interactive centers of science popularization (like the Kharkiv "Landau-center") and, even educational animated films, the digestion of this key discipline, as physics, without the school and skilled teacher is not possible.

Since 2017 we started courses of in-plant training of the regular school teachers on the physical department. They provide the complete middle school course, named "Physics and astronomy" [1]. The professional block of the program was developed by the authors of this article in order

to help the teacher in his everyday work (modernization of materials presentation, resolving challenging tasks, preparation for final school exams, making research in the laboratory), and help teachers to familiarize with modern physical tendencies, views, paradigms. In fact, the school physics course, unfortunately, uses a hundred-year-old material. The Department of Physics of the Karazin Kharkiv National University is one of the top three Ukrainian universities, that is why it has the opportunity to help teachers, and their students as well, to enlarge and deepen the knowledge of modern physics and astronomy.

The professional block of the program consists of four parts:

1. Innovational tools, methods, and forms of studying physics and astronomy at schools.
2. The combination of old and modern views and teaching methods in the physical and astronomy.
3. New directions in modern physics and astronomy.
4. Presentations and grants like a help to the teacher.

This part of the program for training of teachers is the most interesting. Let us have a look at it through some examples. Innovative methodologies of an educational process, that provide brief transfer to the complete studying from the detailed one and have a very important role in teachers training. The new competent approach presupposes providing the rich in content lines.

It is not secret, that nowadays pupils cannot imagine the world, without computers, smartphones, the internet, etc. That is why a teacher why does not use the modern computer methodologies during the lessons of physics hardly will be considered as an authoritative and clever person among schoolchildren. It not enough to use presentations or visual effects or even popular scientific films during the lessons. Those pictures can be easily found by everyone on the Internet and they will be followed by professional or non-professional explanations. Instead of it, it is much better to recommend the teachers of physics and astronomy to use the controlled computer animation during lessons.

For example, let us have a look at the computer model of the Solar system that demonstrates the planet motion and orbits as well as asteroids around the Sun. This motion is easily observed on a monitor and, as we all know, it is determined by the gravitation law. It can be easily changed by gravitational constant, that depends on gravity and distance between objects, and you will see the real destruction of the Solar system: orbits will change, planets will fall on a Sun or fly out from the Solar system. The main point here is that a student sees this animation with his or her own eyes, that physical laws or parameters really do not only determine the picture of the Universe, but also determine various physical phenomena around us. There is similar animation is also Bohr model.

In this case, it is possible to change the dependence of force according to the Coulomb's law on the distance between the atom's kernel and an electron that moves on an orbit around kernels or size of charge of the electron. Those amendments cause the substantial change of electron's orbit radius and even to the destruction of an atom that causes the destruction of the whole substance. It is important to add, that the nuclear model of the atom, invented E. by Reserpilum, was built on the basis of analysis of planetary motion around the Sun. It gives an opportunity to show the historical development of physics in evidence. The one can easily see the examples of a direct connection between physics, astronomy, materials science etc. The pupil's consciousness is built this way and their particular and key competencies.

The organization of teaching in the middle school has its own peculiarities. It is important to combine the views about the basic researches directions together with the nature of celestial objects, the Universe model, its origin and evolution, and the role of astronomy in the problem

distribution of life outside Earth exploring. The example of that teaching approach can be found in the corresponding textbook written by one of the coauthors [4].

What approach should the teacher choose for getting the best results? First of all, it is important to make the science interesting through the process organization. The material must be supported by modern multimedia facilities, use of planetariums [5] where it is possible, by the use of animations, and discussions, based on scientific and fantastic films, that has physical and astronomical aims. Together with lecture exposition, it is necessary to use physical and astronomic tasks, based on a mathematical school program. It is necessary for students to feel their potential in resolving independent scientific and theoretical researches, for example, as a part of the Junior Academy of Sciences.

One of the most important aims of the advanced training, according to the authors' point of view, is also in, the extension of the professional teachers' horizons to grow out of the school program and be available to familiarize their listeners with some new directions of modern physics and astronomy. Everybody understands that school lessons are limited in time, thus it is not possible to grasp impossible. Thus, it is better to concentrate on the aspects in modern physics as well as astrophysics that is fundamental both in theoretical physics and in experimental, as well technical one and used in space researches, but very limited by the school program, or not included in it.

The professional part of the program also includes lectures with astrophysical achievements, the views on the nonlinear paradigm of the world, the basic stages and origin of physics of fractals, quantum-mechanical approach on the substance structure. The astrophysical achievements of the latest decades are connected with to the results, combined with large (with apertures about 10 m) earth and on orbital telescopes with the receivers, operating in all spectrum of Hertzian waves. The financing of those astronomical researches can be only compared to the sums that are paid in nuclear physics.

The results were not long in coming. The new class of space bodies - substars (what by the way were envisaged in the Kharkiv University [8]) was explored; acceleration of Universe's expansion, that is explained by the action of Repulsion law; gravity waves; the planets that, were found around the stars and called extrasolar planets. This list is not finished.

The modern teacher of physics should know the scientific terminology, that is used nowadays ("bifurcations", "fractals", "quasiparticles", "dark matter", etc), and it is constantly renovated, and specifications. As an example can be a "cosmography" term, that is now understood in a new way if to compare with XIX century, when it was used to name the whole astronomy. Now the cosmography in educational and scientific literature is a part of the star astronomy that studies the structure of Metagalaxy [9, 10].

The new direction of research of named "Cosmophysics" appeared, that studies the basis of micro and macrocosm, their fundamental bond, that is shown through effects, studied in nuclear physics, astrophysics and cosmology. The unique possibility for the listeners of qualification upgrade courses are the lessons in an astronomical observatory. Teacher directly meets with the wide variety of telescopes (independence to that, what range of waves they are working with), with their work and the usage of them in different constructions - refractors and reflectors. The extra attention is paid to their usage in astrophysical researches, The exploration of the Sun (with a coelostat used), detection of relict and space gamma-radiation, gravitational waves etc.

During the qualification upgrade, the teachers visit the Museum of Astronomy (containing the history of Astronomic School of the Karazin Kharkiv National University from its foundation till current day and its place in Ukraine and abroad), Museum of nature, Landau Center. The final chapter of professional block covers the possibilities of teacher's participation in international cooperation with other scientists. It means getting of educational grants, that make possible the experience interchange, have an internship, participate in researches and conferences, both on the territory of Ukraine and abroad.

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