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NEW TEACHING METHODOLOGY IN HIGHER EDUCATION INVOLVING STUDENTS IN SCIENTIFIC DISCOVERIES AND DEVELOPMENTS

Abstract. The question of new teaching methodology in higher education, is related to the sufficient provision of higher education institution with technical means and modern scientific base. The decisive role in this issue is played by scientific and engineering workers who regularly publish scientific articles of "B" and "A" level, have patents for inventions and utility models.

In institutions of higher education, scientific faculties are created, groups of the most gifted students who work with scientists on scientific projects, grants, patents, participate in experimental work. All the experience of scientific work is generalised and published in the publications of the university, institute and transferred to the practical plane of pedagogical work with the use of the obtained materials for lecture material, practical and laboratory works [1].

The development of science in Ukrainian universities is in decline in comparison with European institutions of higher education, the algorithm of this important work is chosen incorrectly. We do not have a focused state programme that could coordinate all the scientific activities of our universities, and most importantly, the students of institutes and universities are not organically connected with the urgent problems of our time.

The period of profound climatic changes in the life of mankind has come, environmental protection has become the first place of the main activity of the productive forces of the planet. For Ukraine in this regard, the aggression of the Russian Federation, which practically destroyed the
already weak sprouts of scientific work and invention of students, has made a deep imprint. Many students have moved abroad and are currently studying in European and American universities, as a rule, they are school leavers and first-year students.

We need, in this challenging environment, to focus our efforts on selecting the best prepared and motivated students capable of engaging in science and invention. This work is going on quite successfully in a number of universities in Ukraine, and as an example we can use the serious joint work of scientists and cadets of the Danube Institute of the National University Odessa Maritime Academy. Over the last decade, scientists and students at our institute have been actively involved in environmental protection and ocean water issues. The first works carried out at the Department of Ship Power Plants and Systems were on reduction of harmful emissions in exhaust gases of marine diesel engines. For the first time on sea and river vessels there were conducted researches of catalysts - products of Scientific-Production Association Eco-Auto-Titan Ukraine, which were successful, showing high indicators on reduction of harmful emissions in exhaust gases of marine engines and fuel economy. With the involvement of cadets, the Institute won two international grants. Currently, work is being finalised on the creation of alternative fuels from renewable natural resources. Scientists and students of Kyiv Polytechnic University have achieved great success in creating unmanned flying objects, which have been used by the Armed Forces of Ukraine.

**Keywords.** Higher school, students, student involvement in science, Russian aggression, unmanned aerial objects, quality of education.

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**НОВА МЕТОДОЛОГІЯ ВИКЛАДАННЯ У ВИЩІЙ ШКОЛІ, ЩО ЗАЛУЧАЄ СТУДЕНТІВ ДО НАУКОВИХ ВІДКРИТТІВ І РОЗРОБОК.**

**Анотація.** Питання нової методики викладання у вищій школі, пов'язане з достатнім забезпеченням вищого навчального закладу...
технічними засобами та сучасною науковою базою. Вирішальну роль у цьому питанні, відіграють наукові та інженерні працівники, які регулярно публікують наукові статті рівня "Б" та рівня "А", мають патенти на винаходи та корисну модель.

У закладах вищої школи, створюються наукові факультети, групи з найбільш обдарованих студентів, які працюють із науковцями над науковими проектами, грантами, патентами, беруть участь в експериментальній роботі. Увесь досвід наукової роботи, узагальнюється і публікується у виданнях університету, інституту та переносяться в практичну площину педагогічної роботи з використанням отриманих матеріалів для лекційного матеріалу, практичних і лабораторних робіт.

Розвиток науки в українських вищих закладах перебуває в занепаді порівняно з європейськими вищими навчальними закладами, сам алгоритм цієї важливої роботи обрано не вірно. Ми не маємо цілеоспрямованої державної програми, яка могла б координувати всю наукову діяльність наших вишів, а найголовніше - студентство інститутів і університетів органічно не пов'язане з нагальними проблемами сучасності.

Настав період у житті людства глибоких кліматичних змін, охорона навколишнього середовища вийшла на перше місце основної діяльності продуктивних сил планети. Для України в цьому зв'язку глибокий відбиток наклала агресія РФ, яка практично знищила і так слабкі паростки наукової роботи та винахідництва студентства. Багато студентів переїхали за кордон і навчаються нині в європейських і американських вищих, це зазвичай випускники шкіл і першокурсники. Нам необхідно в цих непростих умовах зосередити зусилля на доборі найбільш підготовлених і мотивованих студентів, здатних займатися науковою і винахідництвом. Досить успішно проходити ця робота в низці вищих України, і як приклад ми можемо використовувати серйозні спільні напрацювання науковців і курсантів Дунайського інституту Національного університету Одеська морська академія. Протягом останнього десятиліття в нашем інституті науковці та студенти активно займаються питаннями охорони навколишнього середовища, проблемами вод Світового океану. Перші роботи, проведені на кафедрі Суднових силових установок і систем, були зі зниження шкідливих викидів в випускних газах суднових дизелів. Уперше на морських і річкових суднах було проведено дослідження каталізаторів - продукції Науково-виробничого об'єднання "Еко-Авто-Титан Україна", які пройшли успішно, показавши високі
показники зі зниження шкідливих викидів у випускних газах суднових двигунів та економії палива. Із залученням курсантів, інститутом було виграно два міжнародні гранти. Нині завершується робота зі створення альтернативного палива з поновлюваних природних ресурсів.

Великих успіхів домоглися вчені та студенти Київського політехнічного університету у створенні безпілотних літаючих об’єктів, які стали використовуватися Збройними силами України.

Ключеві слова. Вища школа, студентство, залучення студентів у науку, російська агресія, безпілотні літальні об’єкти, якість навчання.

**Problem Statement.** The system of higher education concentrates a significant scientific potential of Ukraine - 68.9% of doctors and 72.6% of candidates of sciences. Training of 81% of doctoral students and 85% of postgraduates is carried out precisely in higher education institutions, therefore, the quality of human capital training and the scientific basis of innovative development of the economy, scientific, technical and intellectual potential of Ukraine depend on the rational organisation and adequate funding of science in universities. Science in universities, if properly organised, is a source of new knowledge, and on this basis - the creation of new technologies and techniques. The achieved results, in their turn, form the basis for innovative development of competitive industry and economy of the state. Unfortunately, the lack of understanding by all governments of independent Ukraine of the unique role of science as a generator of new knowledge and the basis for innovative development of the economy, as well as tragically prophetic words of the first president of Ukraine that "science can wait", have reduced the science intensity of the gross domestic product of Ukraine to 0.7%, while in developed countries this indicator reaches 60-80%.

One of the ways to form priorities and government orders for science in general, and for universities in particular, could be to attract representatives of enterprises and organisations successfully operating in domestic and foreign markets to determine priorities. It is they who can adequately predict what scientific and technical products will be needed and will be in demand in 5, 10 or 15 years.

10 or 15 years from now. If we concentrate financial and intellectual resources on solving such problems, the result will be much more significant than now. Especially if we involve representatives of such enterprises in the expertise of the completed works, i.e. make them a direct customer of the works for budget funds or on the basis of public-private partnership. Undoubtedly, this is only an idea, the mechanism requires detailed elaboration.
At present, a critical situation has been created, which has completely ruined all the plans for the development of scientific potential of Ukraine, but the war accelerated scientific and technical progress in the defence industry. There is a certain rise of scientific creativity of students in the creation of modern weapons and means of defence of warriors. Many young people are successfully working in industrial laboratories to create aircraft, munitions, means of communication and communication with their participation were created robotic installations for emergency evacuation of the wounded from the battlefield and much more. There are a lot of unresolved issues concerning the legislative level, determination of the status of students working on the needs of the front without interrupting the educational process.

**Analysis of recent studies and publications.** The study of the works of Ukrainian scientists dealing with pedagogy in higher education: Zakharchenko R.M., Afonin E.A., Tokarev V.G., Sikorsky I.M., give every reason to believe that they have done a lot of scientific work in solving the main pressing problems of our institutes and universities. Unfortunately, for a number of reasons they could not finish their work, as they are teachers of universities and first of all their scientific works should have found their full realisation in the field.

**Purpose of the article.** Finding a way and its implementation at the legislative level in the creation of a unified programme in the conditions of war, triune cooperation of scientists, students and industrialists.

In order to overcome the negative impact of the events of recent years, the State Service for Education Quality recently proposed to switch to a 12-year system in schools from 2024, rather than from 2027, as envisaged by the New Ukrainian School reform.

However, Education Minister Oksen Lisovoy said that the transition will not take place in 2024, because it requires an approved state standard on the profile high school, which is only being developed now. Also, such changes require additional funding, which is not provided for in the budget.

According to Lisovoy, the increase in the duration of education cannot be the main tool for overcoming losses in education, so now the Ministry of Education and Science is developing a comprehensive solution.

Ukraine's higher education institutions have faced many challenges since the beginning of the war. In particular, there has been an outflow of both Ukrainian and foreign students. According to the Ministry of Economy, there are more than 500,000 Ukrainian schoolchildren and more than 200,000 students abroad. Not all of these students could have dropped out.
Some of them could have taken a gap year, switched to online learning, or participated in an exchange programme.

The outflow of foreign students due to the war caused material and human losses for Ukrainian universities. We lost about 30% of students from abroad. If we translate this into financial losses alone, the amount will reach more than $300 million a year. The decline in the number of students also resulted in the loss of staff, as universities have to reduce the workload or even dismiss teachers. Reputational losses have occurred, and universities have lost the opportunity to develop their infrastructure with these funds.

At the same time, the number of men among students of Ukrainian higher education institutions increased last year. One of the reasons was the motivation to get a deferral from mobilisation under martial law. But the overall proportion of men in the Ukrainian population has also increased, as many women have moved abroad. Recently, information about a possible ban on military service personnel entering universities has been actively disseminated on social media, Supreme Movietude the has no plans to introduce such a restriction. Undergraduate, graduate and postgraduate students, as well as pupils and students of vocational education institutions, will continue to have a deferral from mobilisation for the period of their studies.

In 2024, applicants will once again take the National Multisubject Test (NMT) instead of the External Independent Testing (EIT), which the Ministry of Education introduced last year to simplify the admission process during the war. The NMT will be held in the form of a computer-based test in one day. It will take 180 minutes to answer questions from three blocks of subjects. Two of them are compulsory (Ukrainian language and mathematics), and one subject can be chosen independently (history of Ukraine, foreign language, biology, physics, chemistry). All NMT tasks will be in line with the current EIT programme. On 3 May, registration for the NMT ends on the website of the Ukrainian Centre for Educational Quality Assessment (UCEQA), and the main session will take place on 5-23 June 2024. The testing will be held in specially equipped computer classrooms of educational institutions - temporary examination centres (TECs) - in cities of Ukraine and other countries. For security reasons, the addresses of the TECs are not advertised in advance. Cedos expert Iryna Kohut told the publication about some of the features of the NMT that may affect admission to higher education institutions. For example, the smaller number of questions in a multi-subject test compared to the EIT means that each question will have more weight in determining the passing score. At the same time, the UCEQA said that this year the test time was extended by an hour to allow
for the addition of questions with a higher level of difficulty. This will allow for a more correct distribution of participants and more accurate results for the admission process [2].

The war has caused irreparable damage in building our potential for future engineering personnel. Destruction by the enemy of industrial enterprises, thermal power plants, power generating facilities. Practically students lost the opportunity to undergo practical training at enterprises and laboratories. The only maritime universities in Ukraine have such an opportunity to learn practical skills on sea and river vessels of foreign companies. In the majority of our cadets later, becoming naval officers, stay to work in companies of foreign shipowners. We once lost a mighty merchant fleet with the easy hand of the grief of the Presidents of Free Ukraine. The war set us back indefinitely in the creation of a powerful naval and merchant fleet with sufficient human resources, which in the near future we can irrevocably lose the best qualified naval officers.

Despite all the difficulties in the development of Ukrainian science and scientific creativity of students, we have good initiatives that give concrete practical results.

The great scientific work of scientists of the Danube Institute of OMA and our creative youth together with the Scientific - production company Eco-Auto-Titan Ukraine, has achieved significant results in reducing harmful emissions into the atmosphere in the exhaust gases of marine diesel engines with significant fuel savings.

For the first time in the world practice, in early 2016 the fuel catalyst was tested on the port tug Portovy 22 of the Ukrainian Danube Shipping Company with the total effective power of the main engines Ne = 700 kW. CO reduction was 49 %, smokiness was reduced by 52 %, fuel economy on running mode was recorded 12 %. In the following years (2017-21018) tests were carried out on transport vessels of the shipping company with Ne = 1600 kW main engines, the test results were similar, in the tests additionally nitrogen oxide NOx was determined in the exhaust gases of the engines, which decreased with the catalyst connected to the fuel apparatus by 38 %. All the results of the study were recorded by a third party independent audit, which was carried out by the Institute of Ecology and Energy Saving of the city of Kiev.

Joint development of NPK "Eco-Auto-Titan and Danube Institute NU "OMA", which incorporated the latest achievements of colloidal chemistry, and nanotechnology, is able to restructure hydrocarbon fuel, improve its combustion and energy efficiency. fuel, improving its combustion and reducing harmful emissions into the atmosphere.
Fig. 1 Fuel catalyst

Fig.1 shows a catalyst of chamber-cassette type, which includes titanium filters-activators of fine purification, active elements of chemical catalyst and granulated catalyst. The first chamber precipitates heavy fractions in the fuel and selectively purifies diesel fuel from sulphur compounds and tars. In the second chamber the fuel is catalytically treated by contact of its hydrocarbon molecules with the highly porous active surface of the granular catalyst, which includes metal compounds and catalytically active organic inclusions. After that the fuel is treated at the molecular level with additive tablets, metal salts, which under the influence of high temperatures and pressure in the combustion chamber of the engine in the form of metal molecules are deposited on the surface of the parts of the cylinder-piston group. In the third chamber, due to the use of titanium activator cups, the modified fuel undergoes additional activation and stabilisation. The effect of catalytic treatment of fuel is retained for 30-40 seconds, which is quite enough to burn it in the engine combustion chamber. Complex fuel treatment increases the completeness of its combustion, which reduces fuel consumption and harmful substances emitted into the atmosphere with exhaust gases.
The use of the developed technology of catalytic preparation of fuel, occurs stepwise with improvement of molecular composition of fuel by catalytic treatment and its saturation with salts of cladding metals, which provides the following distinctive features and advantages of the fuel catalyst:

- reduction of engine wear by reducing friction and restoring the geometry of the surfaces of the engine cylinder piston group;
- 10-20% reduction in fuel consumption
- reduction of pollutant mass in exhaust gases;
- increase of engine oil service life;
- ability to operate in a wide temperature range from – 40° to + 85° C;
- increase of engine power and efficiency;
- versatility of the device design with the possibility to use it in various vehicles [3].

Scientists and students of Ihor Sikorsky Polytechnic University have created a number of new designs of unmanned aerial vehicles, which find their application in the National Economy and in the Ukrainian Army. The latest development this year by scientists and students of the Ihor Sikorsky University allows transporting wounded soldiers from the battlefield remotely, at a distance of up to 10 kilometres [4].

Fig.1 FAX-8 PEGAS-E UAV and its main characteristics.
Take-off weight - 12 kg. Wingspan - 2.7 m. Length - 1.7 m. Flight speed - 50-110 km/h. Flight altitude - 5-1500 m. Payload weight - 5 kg. Flight time with a load of 1.5 kg - 0.5 h. Airframe weight - 8 kg. Engine electric - 2 kW.

Fig.2 FAX-9 Sky Bow-G UAV and its main characteristics

Take-off weight - 8 kg. Wingspan - 2.3 m Length - 1 m. Flight speed - 40-150 km/h. Flight altitude - 5-1500 m. Payload weight - 4 kg. Flight time with a load of 1.5 kg - 1.5 hours. Airframe weight - 4 kg. Single-cylinder - 3.5 hp.

The new technology of teaching in two universities of Ukraine: the Danube Institute of ONMA and the Igor Sikorsky Polytechnic University, is aimed at providing the educational process under the programme of joint scientific works and developments of cadets and students. All scientific topics, which were awarded with international grants and patents, found their practical application in the teaching material of laboratory and practical works.

The works on reduction of harmful emissions into the atmosphere of exhaust gases of marine engines are carried out on specific engines of marine and river vessels during the cadets' swimming practice. The set parameters of the engine operation are analysed by special programs, which give a complete list of harmful components of exhaust gases from the engine, analysing fuel consumption in each operating mode.
Scientists and engineers of the Institute, created and patented the installation for disinfection and treatment of ballast water of ships in accordance with the new requirements D-2 International Maritime Organisation IMO, which is noteworthy this installation won the international grant Ukraine-Turkey. Cadets and students of Turkish National Technical University and Danube Institute of ONMA under the grant programme, conduct research of ballast water of Black, Marmara, Aegean and Mediterranean seas, which are treated and disinfected in the laboratory of our institute. The Ukrainian side donated all documentation for this installation and provided technical assistance in the construction of the installation in Turkey, where the installation is used in two versions, on the ship and at the university.

Former students of the Kharkiv Aviation University named after M.E. Zhukovsky, Odessa Polytechnic University, Kharkiv National University named after V.N. Karazin are currently fighting on the front lines in unmanned aerial vehicle units, as well as working in workshops for the production of their own invented drones. These drones are successfully used in the Ukrainian army and are not inferior to, and in some respects superior to, Russian unmanned objects. For reasons of secrecy, the authors of the article do not disclose the tactical and technical data of the Ukrainian students' drones.

Conclusions. Scientific developments, all the research work of our higher education institutions, must necessarily be popularised in the working materials of methodical work of students. Laboratory and working installations, created on the basis of scientific material, should allow scientific student teams to conduct research work on each selected topic.

In the future, student participation in science should be defined in the main life-important areas of all human activities, selectively taking into account individual and personal capabilities. At present, during the period of Russian aggression, it is necessary to provide maximum assistance and support to scientists and scientific community of students in the development and scientific discoveries related to the issues of national defence and armament of the Ukrainian army.

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