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**POPULARIZATION OF SCIENCE AMONG FOREIGN STUDENTS OF  
TECHNICAL UNIVERSITIES IN UKRAINE AS ONE OF THE IMPORTANT  
AREAS OF MODERN EDUCATION**

**Abstract:** *The pedagogical conditions of the model form of a modern technical specialist, endowed with professional ethics knowledge through the introduction of a science popularization program are determined. The formation necessity process of the professionally oriented worldview for international students on their future scientific and technical activity is substantiated, by using interactive pedagogical technologies of science popularization in the framework of educational activity; distance course introduction of science popularization; the integration of the educational disciplines' content and non-academic activities in a technical university with the purpose of learning environment creation, aimed at education of a modern technical specialist. Methodical recommendations on their implementation are given.*

**Keywords:** *pedagogical conditions, formation, modern technical specialist model, integration training, distance learning, a popularization of science, interactive pedagogical methodology.*

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## ПОПУЛЯРИЗАЦІЯ НАУКИ СЕРЕД ІНОЗЕМНИХ СТУДЕНТІВ ТЕХНІЧНИХ ВИШІВ УКРАЇНИ – ОДИН З АКТУАЛЬНИХ НАПРЯМІВ СУЧАСНОЇ ОСВІТИ

*Анотація:* Визначено педагогічні умови формування моделі сучасного технічного фахівця, озброєного знаннями професійної етики, за допомогою впровадження програми з популяризації науки. Обґрунтовано необхідність процесу формування професійно-спрямованого світогляду іноземних студентів на майбутню науково-технічну діяльність, за допомогою застосування інтерактивної педагогічної технології з популяризації науки в межах навчальної діяльності та упровадження дистанційного курсу; інтеграція змісту навчальних дисциплін і позанавчальних заходів у технічному університеті з метою створення навчального середовища, спрямованого на виховання сучасного технічного фахівця. Подано методичні рекомендації щодо їх реалізації.

*Ключові слова:* педагогічні умови, формування, модель сучасного технічного фахівця, інтеграція навчання, дистанційне навчання, популяризація науки, інтерактивна педагогічна методика.

**Problem setting.** It is well known that in recent years, interest in scientific work, engineering professions and subsequent labor activity in the industrial and scientific spheres has significantly decreased. This situation is typical for many countries, and, of course, for Ukraine, as evidenced by reducing the number of international students coming to study at Ukrainian universities. All over the world, scientists and researchers are trying to solve the problem of “science popularization”, to encourage young people in obtaining scientific knowledge and conducting scientific research, forming scientific skills [1, 2]. Van Eijk and Roth summarized results of the implementation of scientific literacy in everyday world: “In the everyday world, scientific literacy likely does not mean doing well on a test, but it means knowledgeably participating in the contributing to worldly affairs where scientific literacy is required” [3]. According to Roth, “New scientific discoveries and technological inventions render the world increasingly complex and the sense that things are advancing, getting better, seems to be increasingly ambiguous” [4]. Various means are used to solve this problem, such as: news, magazines, books, radio and TV programs, social advertising of scientific popularization, a system of scientific press services and information agencies, contests of popular scientific articles and scientific photographs; scientific festivals, scientific theaters, interactive scientific museums, Internet conferences, online interviews of scientists, scientific auto rallies, scientific cafes and many others.

Stephen Hawking is a well-known physicist and popularizer of scientific research. His popular scientific publications “A Brief History of Time”, “A Short History of Time”, “Black Holes and Young Universes”, “The World in a Nutshell” focus on the fact that it is very important to create public interest, even not about science in whole, but at least about those areas that are very interesting to study [5, 6, 7]. He notes that science is often taught in not very interesting form. Young people learn to memorize mechanically only in order to pass the exam, and do not see the connection between science and the world around them. Hawking emphasizes the fact that it is the representatives of education that should actively promote science among students and schoolchildren, emphasizing that the development of science and technology is possible only if the interest in society in these areas of activity is high enough [8]. It is advisable to use the whole arsenal of modern means, in particular, the Internet, mobile communication opportunities, advertising, etc.

*The purpose of the article* is to identify and substantiate the pedagogical conditions for the forming a model of a modern technical specialist with a high level of professional skills,

knowledge of scientific propaganda and skills of transforming scientific data, incomprehensible to the ordinary people, into interesting and understandable information that will promote greater attraction from young people to scientific problems.

**Recent research and publications analysis.** The European Commission, within the framework of the Horizon 2020 program, is conducting a study on public opinion polls and showing interest in science by the public. According to this program, with a budget of 17.5 billion euros in Europe, by the year 2020, a single scientific space should be formed. Europe builds a knowledge-based economy because Europeans understand that progress is impossible without implementing scientific research. Today, the world has reached such a degree of development, when society absolutely needs a threshold of knowledge that guarantees security and a new quality of life [9].

A few years ago, the European and American Funds of Science conducted a joint study to analyze the problem of popularizing science in different countries of the world. The results showed that in the United States scientific popularization has been put on a very high level. There is a wide media industry that deals with this problem. Undoubtedly, it is possible to notice about such well-known editions as Scientific American printing in more than a million copies per month in ten international versions and sponsored by well-known scientists, Nobel laureates and authorities in various fields of knowledge. The Impact Factor (index of citation and scientific value) of the journal is 3.3 points, while for most scientific journals it equals 1 point [10].

In addition, the United Kingdom also should be noted as the state provides significant support for popularization of science. So, the Department of Science and Technology created a special commission whose purpose is to explain to people why science is important, and that this allows the UK to compete in the global technology market and to be a rich country. Indeed, a special TV channel has been created, which deals exclusively with the promotion of scientific knowledge. Moreover, the bulk of the news on this well-known BBC channel is devoted to the news about renowned scholars and research.

In the UK the European Center for Science and Art named Alpha Galileo Press was organized according to the Science and Society program [11]. It is a daily renewed online resource with science information from all European countries, as well as press releases from various scientific institutions. Among many popular European publications, it should be noted British Journals Nature and New Scientist, which provide information about scientific achievements, and even the only publication in these journals is often considered more valuable for scientists than dozens of articles in other editions [12, 13]. As a result, it should be emphasized that the interest of great part of British youth is directed toward the natural sciences.

According to the director of the European scientific press center Alpha Galileo Peter Green, the responsibility of a modern scientist is a constant dialogue with the public. There are four reasons why a scientist should explain his research to the general public: 1) the commitment of scientists to taxpayers; 2) involvement of young people; 3) participation in discussions on vital problems of science. Scientists propose to follow some basic principles of effective promotion of science. Among them are the following:

- **Adaptation of a complex scientific phenomenon** to some essential formula, general presentation depending on the audience.

- **Using the principle of analogy** that is, comparing the scientific phenomenon with everyday life, so that the first became clear. However, the transition from the language of science to the language of the unprepared audience should be carried out with extreme caution, because any simplification can be perceived superficially and lightly.

- **The principle of emotional attitude to the scientific phenomenon**, discovery, scientific activity. A person who makes messages in the field of science should not be

indifferent to these phenomena.

- **The principle of a practical forecast**, that is the presentation not only research results but emphasizing the possible connection between scientific work and real life.

- **Mastery of presentation**, that is, a clear balance of depth of detail and calculation of the uninformed reader, rigorous dosing of the message logic – all this determines the success of science popularization, especially among international students.

**Paper objective.** A large number of students from more than 148 countries study in Ukraine. An important condition for improving the popularization of science among international students is their awareness, a possibility of access to a specific scientific information adapted for them, which is absolutely necessary, especially in the first stage of studying in a foreign language. Scientists of Ukraine are exploring the effective ways of solving the problem of science popularization among international students, but, unfortunately, these issues still require careful attention from researchers and teachers.

**The purpose** of the proposed program is to demonstrate the necessity and expediency of forces and funds for scientific activities and encouragement foreigners in Kharkiv for it in an accessible way. **The objectives** of the program are as follows:

- providing foreigners with systematic knowledge of the famous scientific inventions both in Ukraine and all over the world;
- acquaintance with the peculiarities of the educational process associated with various scientific areas and scientific research.

**The tasks** of scientific and experimental activity were carried out in several directions:

- studying the possibilities of the educational environment for the science promotion;
- development a psychological and diagnostic package and technology implementation for the science popularization program;
- analysis of existing programs for the science promotion among foreign citizens in Ukraine and abroad;
- development a comprehensive psychological and pedagogical program for the science popularization as a tool for increasing the effectiveness of international students' adaptation to new living conditions, as well as the prevention of extremism and xenophobia;
- approbation this program in the Center of the Science Popularization.

Due to the program's implementation, a concept of educational material was formed; a methodology for presenting scientific information was prepared; a technology of its implementation was developed; a pedagogical experiment was conducted as a logical continuation of theoretical research and checking their reliability, assessing the effectiveness and practical significance of the program.

**Paper main body.** For many decades NTU "KhPI" pays great attention to the popularization of science among international students. The leaders and teachers of the university are keen to create the most comfortable conditions for their learning and life. Thus, international students are given the maximum timely assistance in adapting to a new socio-cultural environment in order to achieve comfortable integration into the Ukrainian scientific and educational environment, as well as in assimilating new methods of obtaining scientific knowledge. Psychologists confirm that foreign citizens as representatives of different cultures may differ from Ukrainians as well as from any other nation [14]. To overcome the challenges of this problem in science and technology sector, international students need to be equipped with the 21st-century skills to ensure their competitiveness in the globalization era.

Firstly, coming to another state is the stage of person's entry into a new macro- and micro-environment. Most foreign citizens have a low level of awareness of science in general, and scientific activity in Ukraine, in particular. At the first time, for many of them, there is a problem of internationalization, a necessity of communication with representatives from another social, ethnic, and national standard. Therefore, at the first stage of the program's

implementation, special conditions for the elimination of the above-mentioned complexities should be provided.

Secondly, this is a stage of socialization and adaptation of the individual in a new social environment. Foreign citizens are socialized conscious individuals, formed under the influence of conditions in which they were brought up, with a determined life position, target settings, and value orientations. In addition, each of them has its own specific features: ethnic, national psychological, psychophysiological, personal and others.

Thirdly, this is a phase of inadequate mental and physical activity. Foreign citizens, who are included in a new macro and microenvironment, may feel natural discomfort, as there is a reorganization, a change in their psycho-physiological processes.

That is why, in our opinion, the formula for a successful process of science popularizing among international students in Kharkiv in particular, and in Ukraine as a whole, includes the following: primary scientific orientation; providing a wide range of information support and counseling; scientific communication organizing.

It is well-known that due to differences in cultures and national mentality, there are specialties in different spheres of life, including the perception of the scientific research significance. In addition, some differences in people interaction, a manner of communication, and doing business in the scientific area are reflected in all life spheres, so knowledge of these differences significantly affect the success of the popularization of science among foreigners.

In this regard, in our university, the program of science popularization for international students begins immediately after their arrival in Ukraine. "Acquaintance Lessons" are held at the first week: 1) acquaintance with the most important scientific objects of NTU "KhPI" and other Kharkiv universities; 2) special classes in English, French and other languages for informing about Ukrainian higher educational establishments, research organizations and programs for supporting foreigners in their further scientific and educational activities. Moreover, foreigners-freshmen are invited to the educational-adaptation course "Peculiarities of scientific research", which aims to provide international students with key knowledge about modern scientific developments of NTU "KhPI" with real practical effect, and, at the same time, familiarity with the system of scientific research in Ukraine.

To determine the effectiveness of the presented program, a pedagogical experiment was conducted. Two groups of international students took part in the experiment: one of them was an experimental (with the program of the popularization of science learning) and the other was a control group (without the proposed program learning).

The pedagogical experiment was conducted for two years and consisted of three stages: establishing, forming and comparative. 208 international students and postgraduates from NTU "KhPI" were involved in various types of research and experimental work. Due to the establishing experiment, the problems related to the latest information technologies, environmental problems, and globalization of the economy were systematized; the level of students' awareness of engineering activities was determined. To solve these problems, a website for online forums, where students and experts could express their views on the issues listed above, was created.

The toolkit for research was questionnaires and surveys. The essence of the questionnaire developed specifically for international students was to clarify their level of awareness of and willingness to participate in scientific and technical activities in Ukraine and in other countries. The questionnaire contained 28 questions specified the attitude of foreigners to the following problems: 1) necessity of science popularization among foreigners in Ukraine; 2) knowledge in different areas of engineering activities for choosing future speciality in Ukrainian university; 3) dependence between the effectiveness of technical activity and professional ethics norms; 4) necessity in training courses "Science in Ukraine"

and “Science at NTU “KhPI” and others. Respondents had to choose one of the four response options: “Yes”, “No”, “Sometimes”, “I do not know”. The analysis of the answers is shown below (Table 1).

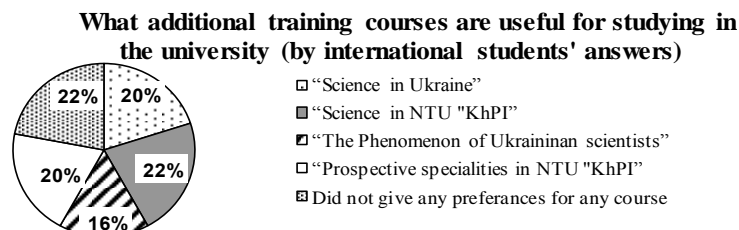
*Table 1*

**International students ‘answers**

№	Issue	Respondents’ answers(%)			
		Yes	No	Sometimes	I don’t know
1	Necessity of science popularization among foreigners in Ukraine	28	10	46	16
2	Knowledge in different areas of engineering activities for choosing future speciality in Ukrainian university	20	25	15	40
3	Dependence between the effectiveness of technical activity and professional ethics norms	10	20	55	15
4	Necessity in training courses “Science in Ukraine” and “Science at NTU “KhPI”	62	8	10	10

The given structure of responses testifies that international students consider that receiving more profound information about scientific achievements and science while their university training is very important and it will be influence able to the effectiveness of their technical activity. However, they do not have a complete idea and integral concept about the importance of science popularization. The analysis of the answers to the proposed problems confirms the relevance of the development of methodological issues on the promotion of science in Ukraine, whose research is being carried out by an increasing number of scholars.

At the stage of the establishing experiment, the students' opinion was also clarified-bout following issues: “What additional training courses do you consider useful for studying in the process of training at the university»: «Science in Ukraine”, “Science at NTU “KhPI”, “The phenomenon of Ukrainian scientists”, “Prospective specialties in NTU “KhPI”, “Your proposal”. These questions caused some difficulties for international students, although the answers were rather monotonous: 22% of students supported the course “Science at NTU “KhPI”, 20% – the course “Prospective specialties in NTU “KhPI”, 20% – the course “Science in Ukraine”, 16% – the course “The phenomenon of Ukrainian scientists”, 22% – did not give any preferences for any course (Fig. 1).



*Fig. 1. Answers of international students of NTU “KhPI” to the question “Which additional training courses you consider expedient to study in training technical specialists at the university”*

The results of the analysis of the establishing stage of the pedagogical experiment allowed the following conclusions to be made.

1. The thesis of international students' little awareness regarding achievements, problems, and significance of scientific research and prospective branches of technical activity of Ukrainian higher education was confirmed.

2. Appropriate directions for improving the international students' training Ukrainian universities in the field of science popularization are determined.

The next stage of the study was the forming experiment. The purpose of the experiment's formation was to check the starting points of the interactive methodology for science popularizing among international students and to identify the level of professional qualities and skills of scientific propaganda formation and development for experimental groups' students. The tasks of the forming stage of the pedagogical experiment were as follows: acquaintance of international students with the basic concepts of international scientific research; analysis of the main theoretical positions on the science popularization, developed both on foreign and Ukrainian base; identification of appropriate variants of science popularization among international students in Ukraine.

To conduct the forming stage of the experiment, interactive courses "The phenomenon of Ukrainian scientists", "Prospective specialties in NTU "KhPI", "Features of scientific research", "Science in Ukraine", "Science in NTU "KhPI" were developed, the educational tasks based on investigation real science issues were formed.

Educational material was developed in the form of lectures and situational tasks (cases). Students received information about the history of the certain technical devices invention, as well as about the actual problems that modern scientists are trying to solve. The historical context of this course is not chronologically confined to the description of a technical tool or a technical project. Also, the information about discoveries, which were the basis for this modern technical equipment, was provided. It should be noted that not only the main functional components of the invention were considered, but also the auxiliaries that contributed to its creation. As an example, the history of a computer was provided not only because of hardware, peripheral devices evolution, but also the history of plastics covering which also is an important computer component. That is, all main components of a certain technical device were analyzed properly, the history of which made it possible to obtain their modern look. The proposed approach provides an opportunity to cover a wide range of scientific activities that have led to this process when studying the history of particular technical facility creation.

The material of the lectures (cases) was not burdened with formulas and specific scientific terms; the process of creating a certain technical tool was based on a statement of what key scientific problems existed at each stage and whom and how they were solved. All these were contributed to raising the interest of the audience to science popularization. In addition, some lectures and practical classes were conducted in the form of "roundtables" with participation of international postgraduate students of NTU "KhPI" and other higher educational Ukrainian institutions, the acquaintance with secrets of scientific developments were held in game form with interactive demonstrations and discussions for different topics, like: "What would it have been if this device was not invented?". Thus, students acquired the opportunity to reach the conclusion about the objective need for their own participation in scientific activities by themselves. In fact, this is an element of novelty in the proposed program.

Great attention was paid to gender issues, such as Arabian female involvement in studying of science and technology practical use. As a rule, it was related to the environmental problems, a culture of life, medicine, nutrition, healthy lifestyles, and other

domestic problems, in which people cannot act without knowledge about the latest developments in computer, chemical, food and other diverse scientific technologies. At the stage of the forming experiment, the following events were also carried out:

- a) practical international students' conferences with a discussion of modern scientific developments' practical significance;
- b) skype conferences with international students from Kharkiv;
- c) meeting with well-known scientists who have made a significant contribution to the development of science;
- d) excursions to the Kharkiv scientific museums;
- e) excursions to the leading departments of the NTU "KhPI" with a demonstration of their scientific achievements.

The electronic packages with the essential information for international students were developed and proposed on the official university site, such as: "Welcome to Ukrainian Science", "Well-known Scientists", "The most important innovations", "International Students Case Studies". For instance, there is full information about the program of science popularization among foreigners, announcements of current events, photo and video reports, adaptation materials for international students with translation in various languages, as well as promotional videos "Science in Ukraine", "Science in NTU "KhPI" and many others. The NTU "KhPI" international students' scientific community was created, and foreigners from Ukrainian higher educational institutions have the possibility to share their experience of training, answer questions, provide consultations etc. through the Faculty of International Education NTU "KhPI" Facebook.

The final stage was a comparative experiment, the essence of which was the attitude of learning outcomes in experimental and control groups. The instrumental tool of the comparative stage of the experiment was psychological and pedagogical diagnostics, which was conducted before studying the course in experimental groups and after its completion. International students gave answers to the same key problems associated with the popularization of science, which were offered to them for analysis at the stage of an establishing experiment. The conditions of the experiment were determined by the fact that the effectiveness of the program is the result of an interaction of several factors: its content and organization, the students' contingent, the personality of the teacher and used pedagogical technologies. Taking into account all these points, the establishing, forming and comparative stages of the experiment were carried out using a comprehensive interactive methodology that allows considering all subjective and objective factors, ensuring their purity, reliability, reliability, and validity of the data received. For the greater reliability of the results of the pedagogical experiment, the following conditions were observed:

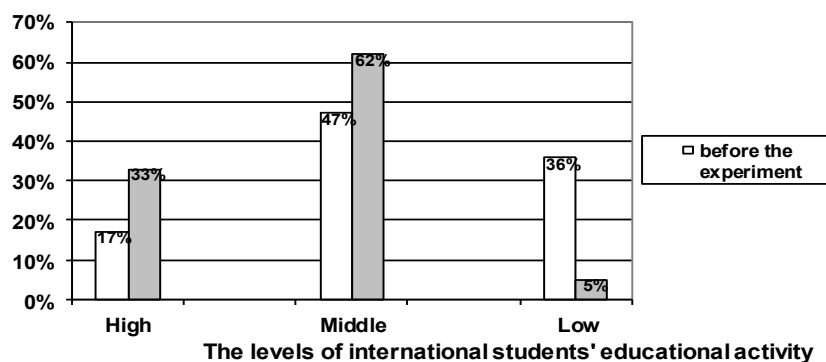
- international students with an approximately equal level of success were selected as groups for pilot studies in order to minimize the influence of changing factors on the result of the experiment;
- the significance of these characteristics relating to carrying out the activities for science popularization was analyzed.

According to the plan, two diagnostic sections in two groups of respondents were conducted: before and after completion of the pedagogical experiment. At the beginning of the experiment, the groups did not differ much in terms of cognitive activity: one-third of students had low levels of educational activity, demonstrated passivity and apathy, and reluctance to leave the hostel. After implementation the proposed program in the experimental group, the percentage of international students with a high level of activity increased from 17 to 33%, the percentage of international students with an average level of activity increased



from 47 to 62%, and the percentage of international students with a low level of activity decreased from 36 to 5%. The situation in the control group remained almost unchanged.

The obtained results of the experiment indicate that the introduction of the program of the popularization of science among international students contributes to increasing their level of educational activities, and acceleration of the process of adaptation to new conditions.



*Fig. 2. Comparison of the experiment's results before and after the program of popularization of science implementation*

### **Conclusions of the research**

A program of the popularization of science among international students will be useful for solving following tasks:

- assistance in solving socio-psychological problems of international students that arise under the influence of changing the place of residence (in particular, problems of social isolation etc.);
- formation an atmosphere of tolerance and prevention manifestations of xenophobia and extremism in educational institutions;
- increasing an intercultural competence of all participants;
- involvement international students in further scientific activity and continuation of appropriate training;
- increasing the number of international students who will be actively engaged in postgraduate and doctoral studies;
- promoting education at Ukrainian universities for those young people who are just about to come to Ukraine to study.

Teachers, sociologists, specialists in technical and natural sciences should be involved in activity regarding preparing educational materials for the program of science popularization implementing [15]. Furthermore, there is a strong necessity to study the forms and methods of science popularizing used in world practice. Technologies for implementing the proposed program provide several areas of preparatory work: development of the necessary training materials, teacher training, and using different forms of multimedia presentation and computer simulations [16].

The analysis of scientific researches and the experience of implementing the science popularization program among international students of NTU "KhPI" suggests that the proposed methodology is compulsory and sufficient for the effective formation of a new international students' outlook based on the peaceful, expedient use of scientific achievements, care for the environment and development of new scientific areas. The prospect of further

research in this direction is considered in creating different distance courses for popularization science activity among international students in Ukraine [17,18, 19, 20].

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