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**SCIENTIFIC AND PRACTICAL TRAINING COMPONENT OF HIGHER
EDUCATION APPLICANTS BY IMPLEMENTING THE DIGITALIZATION OF
THE INFORMATION SPACE**

Abstract: the article deals with the problem of forming a competent understanding of students' scientific research work as a component of the training specialists system in the technical field. The main attention is paid on the experience of technical universities in Ukraine in the implementation of various forms of the scientific research work in the educational process. It is proved that the students' scientific research work has a two-level end-to-end character. The expectations of respondents regarding the implementation of different forms and methods of the scientific research work into the educational process are described. The self-evaluation of bachelors was based on the personal experience of students participating in various types of scientific activities. The historical experience of introducing forms and methods of student scientific research work based on the use of archival statistical materials is investigated. It is emphasized that the new conditions that have arisen with the spread of the COVID-19 pandemic and the full-scale war started by the Russian Federation have made certain changes to the conduct of scientific activities with students. It is necessary to revise approaches to its organization in order to integrate into the globalized information society.

Key words: scientific work; digitization; students of higher education; archive; documents; electronic resources; information space.

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НАУКОВО-ПРАКТИЧНА СКЛАДОВА ПІДГОТОВКИ ЗДОБУВАЧІВ ВИЩОЇ ОСВІТИ ЧЕРЕЗ ІМПЛЕМЕНТАЦІЮ ЦИФРОВІЗАЦІЇ ІНФОРМАЦІЙНОГО ПРОСТОРУ

Анотація: у статті розглянуто проблему формування компетентного розуміння студентами науково-дослідницької роботи як складової системи підготовки фахівців технічного профілю. Основну увагу приділено досвіду технічних університетів України щодо впровадження різноманітних форм науково-дослідної роботи в навчальний процес. Доведено, що науково-дослідна робота студентів має дворівневий наскрізний характер. Розроблено структурно-логічну схему наскрізного виконання науково-дослідної роботи студентів. Охарактеризовано очікування респондентів щодо впровадження в навчальний процес різних форм і методів науково-дослідної роботи. Самооцінка бакалаврів базувалася на особистому досвіді студентів, які займаються різними видами наукової діяльності. Вивчено історичний досвід впровадження форм і методів науково-дослідної роботи студентів на основі залучення архівних статистичних матеріалів. Закцентовано увагу на тому, що нові обставини, які виникли з розповсюдженням пандемії COVID-19 та розв’язаною російською федерацією повномасштабною війною внесли певні корективи і до проведення наукової діяльності зі студентами. Ситуація викликала потребу переглянути підходи до її організації з метою інтеграції до глобалізованого інформаційного суспільства.

Ключові слова: наукова робота; цифровізація; здобувачі вищої освіти; архів; документи; електронні ресурси; інформаційний простір.

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Розширена анотація для ознайомлення з цією темою:

**“Науково-практична складова підготовки здобувачів вищої освіти через
імплементацию цифровізації інформаційного простору”**

Постановка проблеми в загальному вигляді та її зв’язок із важливими науковими чи практичними завданнями. Сучасна система технічної освіти стає все більш інтегрованою і має надавати додаткові можливості для професійного розвитку майбутнього фахівця. Важливе

місце в системі підготовки фахівців технічного профілю займає науково-практична складова, як у процесі навчання, так і в позааудиторний час. Світові та запропоновані національні стандарти вищої освіти спеціалізацію викладання розглядають як базу самостійної та творчої

роботи, яка є елементом науково-дослідної діяльності. На цьому принципі базуються новітні, інноваційні технології навчання.

Аналіз останніх досліджень і публікацій, у яких започатковано розв'язання цієї проблеми і на які спирається автор. Різноманітні аспекти впровадження наукової роботи зі студентами стали предметом наукових досліджень як вітчизняних, так і зарубіжних учених. Корисним є досвід різних закладів вищої освіти, зокрема у контексті створення віртуальних лабораторій Вроцлавського політехнічного університету, впровадження інноваційної моделі на основі активних методів навчання для підвищення мотивації студентів у Чернігівському технологічному університеті, посилення взаємозв'язку теорії та практики у підготовці майбутніх педагогів Інституту спеціальної освіти Педагогічного університету в Кракові.

Формування цілей статті (постановка завдання) є обґрунтування методологічних засад впровадження студентської науково-дослідної роботи в освітню сферу, виявлення основних тенденцій модернізації навчального процесу технічних спеціальностей на основі цифрової та інформаційної трансформації освітнього простору.

Виклад основного матеріалу дослідження з повним обґрунтуванням отриманих наукових результатів. Впровадження наукової та практичної роботи у систему підготовки здобувачів вищої освіти в Україні має давню традицію. Зокрема, ще під час створення першого технічного закладу Наддніпрянської України – Харківського практичного технологічного інституту було вирішено надати закладу особливого «практичного» характеру. Проведений аналіз формування підходів до організації самостійної роботи студентів другої половині ХХ ст. дає змогу стверджувати, що науково-дослідна робота була однією з найважливіших складових системи підготовки. На початку ХХІ ст. стало важливим сфор-

мулювати нові вимоги до змісту інженерної освіти. Це тісний зв'язок, співпраця з промисловістю та бізнесом, заснований на традиціях вітчизняних науково-технічних шкіл, включаючи кращий досвід іноземних університетів. У разі технологічних змін, ступеня новизни інноваційних технологій освіта майбутніх інженерів має стати більш адаптованою до вимог сучасних тенденцій на виробництві. Статистичні дані, отримані на основі опитування бакалаврів освітньо-професійної програми “Інформаційно-вимірювальних технологій і систем” 2019 року, свідчать, що, на думку бакалавра, найбільш корисними науковими аспектами були такі наукові проєкти, як узгодження тематики кваліфікаційних дипломних робіт із специфікою базових підприємств та безпосередня участь у них. Менш корисними бакалаври вважають написання рефератів і статей. Сучасні реалії, пов'язані із запровадженням різноманітних обмежень, пов'язаних із поширенням пандемії COVID-19 та повномасштабною війною, розпочатою російською федерацією актуалізують питання вдосконалення форм і методів самостійної роботи студентів, мотивації їх до дослідницької діяльності. Особливістю науково-дослідної роботи студентів сьогодні є широке використання інформаційно-комунікаційних технологій, що надає низку переваг: широкий доступ до джерел інформації, інтерактивний характер взаємодії з інформацією, формування творчого потенціалу, інформаційної культури. Наукові публікації та нормативні документи в електронному вигляді є невід'ємною частиною цифровізації суспільства та важливою основою для організації науково-дослідної та дослідно-конструкторської роботи студентів.

Висновки з даного дослідження та перспективи подальших розвідок у даному напрямку. В системі підготовки здобувачів вищої технічної освіти однією з важливих складових є науково-дослідна діяльність студентів. Це початковий рі-

вень підготовки майбутнього вченого, фахівця, без якого не може ефективно існувати система підготовки. В умовах онлайн-навчання важливість проведення дослідницької роботи зі студентами не стає менш необхідною. Проте підходи до її організації потребують перегляду з урахуванням сучасних вимог цифрового

суспільства. Для інтеграції у глобалізований інформаційний простір здобувачів вищої освіти необхідно спрямуватися на формування навичок пошуку та критичного опрацювання інформації, проведення та представлення наукових результатів із застосуванням новітніх інформаційних технологій.

Problem setting. The modern technical education system is becoming more integrated and should provide additional opportunities for professional development of a future specialist. The important place in the training specialists system of the technical profile is a scientific research component, both in the process of training and outside of classroom time. The student scientific research work in Higher Technical Education Institution has gradually become an important factor in the training of highly qualified specialists and it is an integral part of an independent work. The involvement of future specialists in a scientific work and research activities increases the complexity of the students' acquired knowledge, skills and abilities in the process of performing their scientific work. The world and proposed national higher education standards, specializing in teaching consider as a base of independent and creative work, which is an element of scientific research activity. With this principle the latest, innovative studying technologies are based.

Recent research and publication analysis. Various aspects of student scientific research have been considered by a great number of researchers. Useful for the study was to study the experience of organizing student scientific work in different educational institutions. The peculiarities of implementation of students' research work in the educational process at the Wroclaw University of Technology was investigated by T. Walkowiak [18] in the context of creating virtual laboratories. The author classified different types of simulation laboratories and analyzed both positive and negative experiences. At the Chernihiv University of Tech-

nology, the innovative learning models were introduced into the educational process to increase the motivation of engineering students and extracurricular work based on active teaching methods [16]. The Department of Chemistry of Kharkiv National Highway University has a positive experience in the organization of scientific research [5]. Scientific collaboration between teaching staff and students in the field of geoscience has contributed to the introduction of innovation in the training system. Within the GEOC-SENSE project, methods of active pedagogy based on the involvement of information and communication technologies were used [4]. The perspective experience of students' research work organization in educational institutions of Azerbaijan is covered in Aliyev [1] publication. The example of the implementation of the SABAH project at 7 Baku universities has shown that the creation of a scientific environment in educational institutions is a base for students to be able to solve research tasks during the period of achieving their future profession.

The model of training based on the theory and practice integration is presented in studies by Shulman [13]; Wrenn J. Wrenn J. and Wrenn B. [19]. The necessity of a close relationship between theory and practice through the training of future teachers of the Institute of Special Education of the Pedagogical University in Krakow is emphasized by the authors Baraniewicz and Jonak [2]. An interesting experience of the training of metrologists from Bosnia and Herzegovina in the new Master's program was analyzed by Zaimović-Uzunović and Lemeš [20]. The University of Zenica, in cooperation with the University of Erlangen and the University of

Maribor, with the support of the EC EU TEMPUS SCM project and the Ministry of Education of the canton the unique training system for metrologists of different levels was developed. The realization of the “Complex program of education, training and re-qualification metrology practitioners” in Lithuania was covered in detail by the authors Meskuotiene, Zilinskas and Zabolotnas [10]. The analysis of the Master's educational programs has shown an increase in hours for scientific and practical work.

Myguschenko and Tverytnykova [11] have considered the issues of organic combination of deep theoretical training of engineers with the practical activity in the conditions of higher technical school reforming of Ukraine. The authors have revealed the idea of a cluster approach, as a promising and effective form of science integration, education, business, and emphasized that one of the factors in the formation of educational and production cluster is the introduction of all aspects of a student scientific research work.

Based on the analysis of scientific literature on the development of engineering education in the USA, Germany and England, a comparison of different pedagogical approaches to the organization of systematic training of engineers has been made. It is proved that in different educational institutions during the nineteenth century – the beginning of the twentieth century “an academic drift” was constantly happening. In other words, the education process was initially based on a theoretical base and, over a short period of time, trends shifted towards some practical training [7].

Undoubtedly, the research activities increase the motivation for learning and contribute to the formation of professional competence and its implementation of various pedagogical approaches contributes to the formation of professional competences for future professionals. In particular, the formation of professionalism of future teachers requires a positive attitude to the chosen profession through conceptualization of their own pedagogical experience [9]. The in-

volvement of students in scientific projects forms the ability to conduct full-fledged scientific work and to have a methodology for scientific search of technical specialties [17]. In the process of implementing scientific research technologies, special attention should be paid to the development of search and creative abilities [6].

Paper objective of the article is to substantiate the methodological foundations of introducing a student scientific research work into the educational sphere, to identify the main tendencies for modernization of technical specialties educational process based on digital and informational transformation of the educational space.

Methodology and methods. The methodological base of the study was the use of a set of methods. In particular, the involvement of the retrospective analysis method and the problem-chronological method gave the opportunity to divide broad themes into narrower ones while studying the historical experience of introducing different forms and methods of students' scientific research work on the base of statistical materials processing of reports on the scientific research work of Ukrainian technical institutions. In addition, the methods of analysis, synthesis, classification and generalization were used. On the basis of studying of the specialty standard and the new and upgraded curricula of the bachelor and master degree preparation of the metrology and information-measuring technique specialty a comparative analysis on the implementation of a students' scientific research work during the classroom and after-hours setting has been conducted. The development of a new standard of the specialty in 2018, as well as the result of cooperation with employers, stimulated the revision of curricula and renewal of the organizational forms of scientific and research work of students. Based on the application of the pedagogical content analysis of statistical reports on the student's academic performance, the participation protocols in various competitive events, the magazines of student scientific societies, the

reports on the employment from 2015 to 2020 was evaluated the dynamics of the implementation of the scientific and practical components in the educational process taking into account the improvement of the education quality in the modern training. The results of the study are shown in figures 1, 2, 3.

Paper main body. The introduction of a scientific research work into the training of specialists at the Higher Technical School of Ukraine has a long tradition. In particular, even at the time of the creation of the first technical institution of the Dnieper Ukraine – Kharkiv Practical Institute of Technology, it was decided to give the institution a special “practical” character. Gradually, a necessary component of studying in the polytechnic higher education institutions of Ukraine was the practice at enterprises for students and teachers. The departure of teachers and students of the institute to industrial enterprises of Ukraine and abroad, first of all to the countries of Western Europe, facilitated the carrying out of scientific researches which had applied the character, maintenance of constant relations with scientific societies. This connection with industry, which was intensively developing in the East of Ukraine at that time, was extremely important as a mean of expanding scientific and technical search. In the late 1940s, higher technical education institutions (HTEI) turned to the practical base of training specialists as the main component of the technical education system. Senior students were involved in the research work of the departments. The main form of students’ scientific work of that time was student scientific circles that enabled talented students to realize their creative potential.

The popularity, necessity and importance of the practical training component of the engineers have led to the expansion of this component of student learning. On the base of student scientific circles the student scientific and technical societies (SSTS) were organized at special and general departments of higher technical education institutions.

An important form of the introduction of aspects of students' scientific activity was

the formation of the diploma design theme in the areas of scientific research of the competent department. The connection of the scientific themes of the department with the diploma projects themes contributed to the development of the ability to apply the accumulated theoretical knowledge in practical work.

In the early 1960's, in order to enhance students' practical training and develop their independent skills, new forms of scientific research work organization were created – the student project and design bureau (SPDB). The bureaus included senior students who already had some theoretical background that promoted their scientific, technical and creative potential. The participants of SPDB were engaged in scientific researches, approbation of results, and implementation of developments with industrial enterprises within the limits of carrying out of the state budgetary and economic contractual subjects of departments. Involving students in real scientific and technical creativity had close connection with the education process and provided a high level of science and technology projects.

The technical profile training program contains such an important aspect as a course design. The course project (work) is aimed at gaining practical skills in accordance within the specialization. The course work is also a generalization of the knowledge acquired by the student during the study of professional disciplines cycle. The theme of diploma designing was offered in accordance with the scientific subject of production enterprises, research institutes and design bureaus. Representatives of enterprises and industry research institutes were also involved in scientific management.

In the 1970's, the idea of creating scientific-industrial educational complexes was created in KhPI, which gave an opportunity for a student to acquire practical skills. The search for new approaches was continuing. The revision of curricula and work programs was aimed at strengthening the fundamental and general training of specialists. The development of scientific research work of the

Higher Technical School made it possible to expand the laboratory workshop, to provide it with the latest equipment and computing equipment of that time. The presence of experimental production facilities at leading High Technical Scientific Institutions made it possible to develop and implement exploratory prototypes in small-scale production.

One of the aspects of the scientific research work was the organization of thematic student seminars as an active form of training. The methodology of the seminar is based on a discussion on a specific topic, discussion of current problems of technology, which allows combining lectures with students' independent work. An important component of student scientific activities was the involvement of the most prepared students to participate in the industry contractual subjects of the institutions. Thus, the students' participation in the departments research work influenced not only on the improving of specialists professional training, but also determined the real contribution of future specialists in the development of the national economy. The volume of students' scientific research works was gradually increased. A

common form of students' scientific research work was participation in competitions of different levels during the second half of the twentieth century [16].

The conducted analysis of the approaches formation to the organization of students' independent work during the second half of the twentieth century makes it possible to state that scientific research work was one of the most important components of specialists training of in the technical profile. The defining feature of the scientific and educational activity of the leading technical universities in Ukraine was the search for new organization forms of the educational process and cooperation with manufacturers. The course and diploma course design were expanded. The training included scientific research work, in particular the organization of thematic student seminars and scientific societies, holding scientific and practical conferences of young scientists. In order to enhance students' practical training and develop their individual skills, student design offices were created. The level of engineering training was supported by newly established scientific student studios (fig. 1).

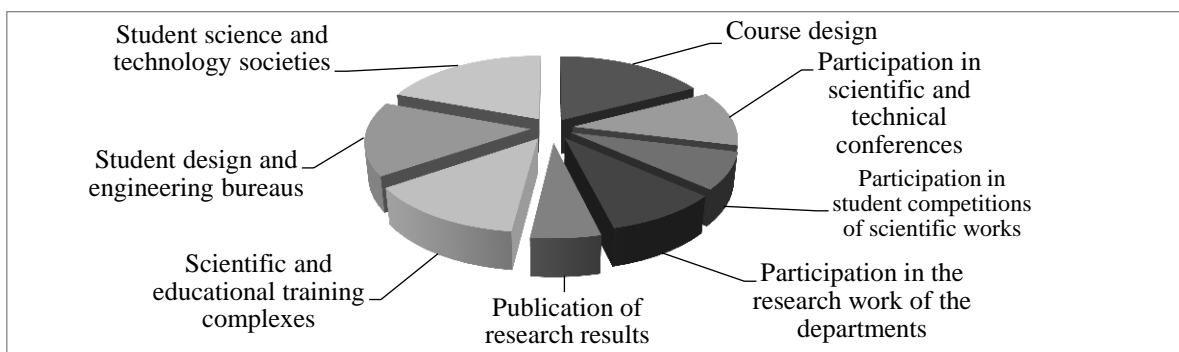


Fig. 1. The system of students' scientific research work organization of technical specialties during the second half of the twentieth century

Thus, during the twentieth century, in particular until 1991, forms and methods of cooperation between higher technical schools and industry were worked out. The role of technical higher education institutions, which in addition to the social function became the drivers of economic development, especially in the field of innovation gradually changed.

Innovation, which is an integral part of scientific and educational activities for the vast majority of European educational institutions, is a rather new introduction for Ukrainian higher education institutions [15].

The system of higher education institutions preparation in Ukraine underwent numerous attempts at reforming and updating

during 1991-2000, now it is a matter of serious concern for scientists and employers, most of whom believe that the quality of training and qualification level of modern graduates remains inappropriate for business needs. The discrepancy between graduates' knowledge and employers' requirements is confirmed by the results of interviews with business executives. The severity of the connection between business, education and science is a common social problem of national importance. The Ukrainian market for educational services cannot be innovative as long as it is based on outdated cooperation forms, organizational structures of science and outdated technical facilities.

At the beginning of the 21st century it is important to understand properly and formulate new requirements of the state and the professional community for the content of engineering education. Engineers should be trained by Ukrainian technical institutions in close connection and collaboration with industry and business, based on the rich traditions of domestic engineering schools including the best practices of foreign universities.

NTU "KhPI" proposes the introduction of an innovative cluster model, which is the most successful when developing new approaches in the educational sphere. The structure of the regional high-tech cluster is based on the vertical integration of enterprises and educational institutions, which helps to create not a spontaneous concentration of technological inventions, but a system of dissemination of new knowledge, technologies and innovations. Based on the innovation cluster model, it is possible to form the directions of common activity within the defined cluster. In particular, it can be conducting such joint projects as technological foresight; career fairs; internships for both students and teaching staff and development of scientific programs [12; 14].

As well as the involvement of business representatives in participating in the orientation and students selection and programs audience, adjusting curricula, pro-

grams and the process of preparing students for their chosen profession and planning further careers of specialists and support. In addition, it can be training on request of corporate clients, teachers' and practitioners' exchanges, teachers' participation of educational institutions in the work of companies and invitations to the teaching of specialists in enterprises. An important aspect of cluster activity is corporate sponsorship of departments and research activities of educational institutions.

It is important to have a scientific component in the training of an advanced engineer. In the case of technological changes, the degree of novelty in innovative technologies, the education of future engineers should become more adapted to the requirements of modern trends in the production. And the promising character of the educational process is achieved through the integration of the educational environment on the basis of the educational, research and production complex. The specific experience in the research competence formation can be traced to the example of training in the field of metrology. In the late 1990s, in Ukraine, as in many countries that gained independence, the creation of a national reference base and the organization of its own system of metrological support became relevant. That is, there was a transition from the Soviet centralized model to the European system. To implement these tasks, the approaches to the training of highly qualified both scientific and engineering staff were reviewed, and the new educational and professional training programs for bachelors and masters in metrology were created.

The object of professional activity in the specialty is transformative engineering, which is aimed at such functional directions as operation, design, construction, technology and science. The integrated result of mastering the bachelor's and master's degree programs, gaining theoretical knowledge and practical skills, the formation of research competencies should occur on the basis of a scientific research work, both educational and under the guidance of teachers (fig. 2).

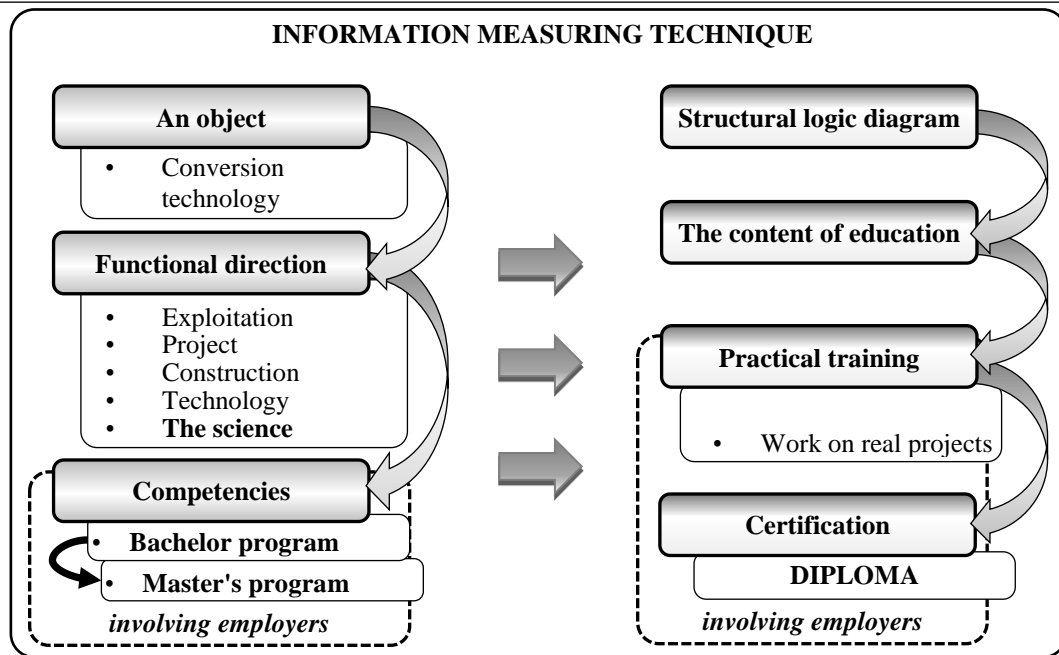


Fig. 2. Model of training specialists by “Information and Measurement Technologies and Systems” educational and professional program,

Studying the structure of specialists training by “Information and Measurement Technologies and Systems” educational and professional program, which include modern curricula and educational and professional programs of specialists training give an opportunity to confirm that scientific research work on a specialty has end-to-end character. In addition to the scientific research work, which in different forms is presented in the curriculum of the disciplines of general and professional training, students are involved in the work of the student scientific circle and student organizational and mass and competitive events of various levels: scientific seminars, forums, conferences and competitions of scientific works. Subject groups in special disciplines (for example, a group in electronics) are aimed to familiarize with the problems of science, to study more deeply, to master the principles, methods, methodology of doing scientific work, to develop the students’ basic skills necessary for further independent works. It is important at the stage of bachelor preparation to hold seminars and workshops on professional disciplines.

At the level of preparation, master's scientific research work is being imple-

mented at the first academic level as an element of independent work in the Test Control of Measuring Channels of Systems, Modern Scientific Schools of the Department of Information and Measuring Technologies and Systems. In addition to the specified forms of scientific research work, it is also practiced to create special programs to attract students who have motivation and incentive to research. The results are presented at all-Ukrainian and regional competitions of student scientific works. Traditional for NTU “KhPI” was the holding of the International scientific and practical conference of masters and graduate students “Theoretical and practical studies of young scientists”.

According to the results of the analytical study of the unified database of student performance records of NTU “KhPI” of the “Information and Measurement Technologies and Systems” specialty for the period 2016–2019. It has been established that the implementation of new curricula in 2018 and, as a result, strengthening of the scientific and practical component of bachelor training contributed to the progress of students in special disciplines. In 2018–2019 the number of students participating in professional

Olympiads, contests of students' scientific works was increased, the scientific publications at the bachelor's level, the participation in conferences. The statistical data obtained on the basis of the bachelor survey 2019 shows that, in the bachelor's opinion, the most useful scientific aspects were such scientific aspects as the agreement of the subject of qualification diploma works with the specifics of the basic enterprises and the direct

participation in the development of the inter-university and international scientific cooperation. Less useful bachelors consider such scientific activities as writing essays and articles as traditional pedagogical approaches (fig. 3). It can be concluded that the bachelors, who took an active part in various activities more consciously began to study for a master's degree in a specialty.

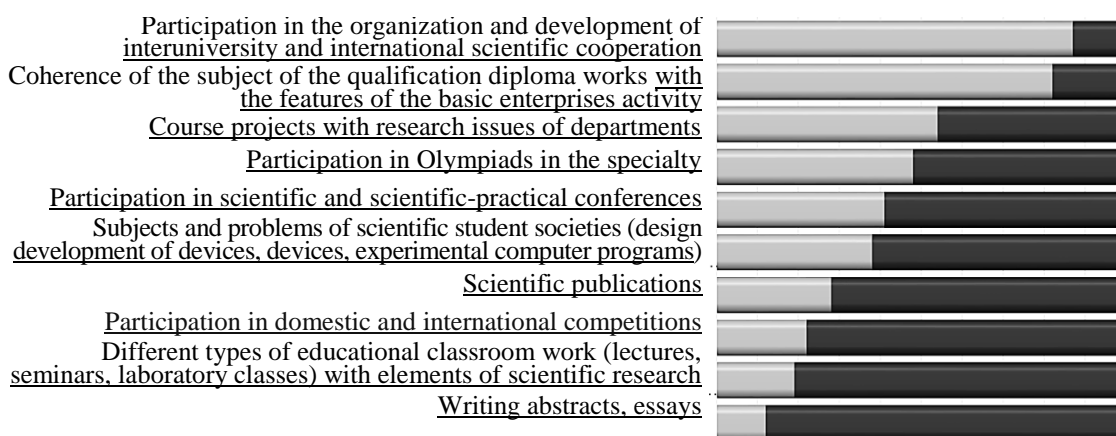


Fig. 3. Data on the study of the importance of basic aspects of scientific and practical training

The present-day realities associated with the introduction of various restrictions related to the spread of the COVID-19 pandemic emphasize the need to develop new approaches to the research and development process. New circumstances that have made certain changes to the process of teaching and research with students have arisen in connection with the full-scale war initiated by the Russian Federation. Without exception, the issues of improving the forms and methods of students' independent work and motivating them to research have become relevant. The digital transformation of science and education is underway. The peculiarity of students' research and development work today is the widespread use of information and communication technologies. The involvement of information technologies in students' research work provides a number of advantages: wide access to information sources, interactive nature of interaction with information, formation of creative potential, and information culture. The new conditions

for the organization of the educational process also affect the modernization of information and library activities: digitization and creation of digital collections of scientific literature and wider use of distance learning platforms. Scientific publications and regulatory documents in electronic form are integral to the digitalization of society and an important basis for organizing students' research and development work.

Conclusions of the research. Therefore, in the system of training specialists in technical direction one of the important components is the scientific research activity of students, which helps to stimulate the creative potential, forms the ability to conduct a full-fledged scientific work and helps to possess the methodology of scientific search for future specialists. This is the initial level of training of a future scientist, a specialist, without whom the system of training cannot exist effectively. As the experience of using various pedagogical approaches shows such a complex of means of attracting students to

scientific and engineering activities strengthened the qualitative component of the educational process and the acquisition of scientific competencies in the professional field. The student scientific research work within the educational program of the information-measuring technique specialty consists in the practical orientation of academic disciplines starting from the first years of training; obtaining significant results of the professional growth by choosing a training profile; the implementation of course projects in professionally-oriented and professional disciplines; the organization and conduct of undergraduate practice on the base of leading enterprises, organizations and institutions;

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performing the relevant graduation work. In the conditions of online training, the importance of conducting research work with students is not becoming less necessary. Nevertheless, approaches to its organization need to be reconsidered to meet the modern requirements of the digital society. It is necessary to direct higher education students to develop the skills of searching for and critically processing scientific information, conducting and presenting scientific results using the latest information technologies, and registering intellectual property rights in order to integrate into the globalized information society.

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