

## 2.2. INNOVATIVE TRENDS IN HIGHER EDUCATION IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT (ON THE EXAMPLE OF PHYSICS AND TECHNICS DISCIPLINES)

The ongoing innovation processes have exacerbated the traditional problems of higher physics and technics education. Modern socio-economic realities require higher education to form in future professionals systematic, interdisciplinary knowledge necessary for the rational understanding of avalanche-growing volumes of diverse information to solve new, non-standard problems. Therefore, a worker with technical education in the process of training should develop the ability to find and analyse the necessary information, formulate problems and hypotheses, identify existing patterns in the available data, find solutions to complex interdisciplinary problems according to innovative trends. This, in turn, necessitates the improvement of professionally oriented training of future specialists in technical specialties considering the requirements of sustainable development of society.

A new paradigm for the development of society, called «sustainable development», was developed due to the awareness of the catastrophic degradation of the environment and the need to find ways to overcome threats to the environment. First of all, sustainable development is understood as a special form of interaction between society and nature, which can ensure the survival of mankind and the preservation of the environment in the future.

Today, sustainable development is the basis of public policy in many countries. Ukraine has officially supported some international decisions on sustainable development, such as «Agenda 21»<sup>325</sup> (Rio de Janeiro, 1992), the UN Millennium Declaration<sup>326</sup> (2000), the Johannesburg Declaration<sup>327</sup> the Implementation Plan of the UN World Summit on Sustainable Development<sup>328</sup> (Johannesburg, 2002), «The Future We Seek»<sup>329</sup> (Rio de Janeiro, 2012).

The National Paradigm of Sustainable Development of Ukraine (2012)<sup>330</sup> defines the concept of «sustainable development» as «harmonious, balanced, conflict-free progress of earthly civilization, groups of countries (regions, subregions) and individual countries of our planet according to scientifically sound plans (systems approach) ), when in the process of steady innovative intensive economic development of countries at the same time positively solves a set of issues related to environmental protection, elimination of exploitation, poverty and discrimination of each individual and entire peoples or groups, including ethnic, racial or gender».

The analysis of the mentioned normative documents and concepts shows that sustainable development presupposes balanced satisfaction of the needs of the current generation without harming the future in the social, economic, and ecological spheres of society at the general civilization, state, and regional levels.

The UN normative documents define quality education as one of the key goals of sustainable development (UNESCO (2015))<sup>331</sup>, which is explained by the fact that education is the most important factor in ensuring the sustainable development of mankind for the following reasons:

- a person learns throughout life;
- a specialist in any field is not limited to the system of formal education;
- in the process of education there is an opportunity to educate conscious members of society to understand the relationship and interdependence of man and nature, awareness of the need to maintain global balance and involvement of everyone in environmental issues;

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<sup>325</sup> Конвенция ООН (1992). Повестка дня на XXI век.

<sup>326</sup> Декларация тысячелетия Организации Объединенных Наций (2000).

<sup>327</sup> Йоханнесбургская декларация по устойчивому развитию (2002).

<sup>328</sup> План выполнения решений Всемирной встречи на высшем уровне по устойчивому развитию (2002).

<sup>329</sup> Будущее, которого мы хотим.

<sup>330</sup> Патон, Б. Є. (ред.) (2012). Національна парадигма сталого розвитку України. Київ: Державна установа «Інститут економіки природокористування та сталого розвитку Національної академії наук України». 72 с.

<sup>331</sup> UNESCO (2015) Education 2030: Incheon Declaration and Framework for Action for the Implementation of Sustainable Development Goal 4.

– the system of physics and technics education creates conditions for the dissemination of knowledge, skills, abilities to make appropriate decisions in accordance with the innovative transformation processes taking place today.

Numerous scientific researches are being carried out in this direction, which additionally confirms the relevance of the development of higher physical and technical education for further effective development of society. Thus, Van Poeck and Lysgaard (2016, p. 305)<sup>332</sup> noted that the principles of modern vocational education need to be rethought and improved in line with the sustainable development of society. Currently, all aspects of studying the features of the future professionally oriented activities of specialists in technical specialities are focused on technical aspects. The issues of energy saving, the economy of material and human resources, focusing on social rather than market aspects of the activity are considered rather superficially, which in turn forms the appropriate style of thinking of the employee.

Lozano and Barreiro-Gen (2019)<sup>333</sup> conducted a thorough analysis of educational programs to determine the degree of integration of the principles of sustainable development in higher education institutions (HEIs). According to the results of the study, the researchers concluded that there are only studies of certain economic and environmental issues, and other issues, including social issues of sustainable development, are not studied.

The analysis of scientific publications on the research problem shows that in most cases the efforts of scientists are aimed at informing the population about the developed principles of sustainable development. It is believed that an informed citizenry will act following the tasks outlined to achieve a fixed goal – to ensure sustainable development of society. At the same time, the formation of the ecological culture of the future specialist is considered to be the primary and even the main one. However, we agree with scholars such as Zafar, Saeed, Zaidi and Waheed (2021)<sup>334</sup>, that this approach is rather one-sided. We do not reject the importance of the information campaign on the implementation of the principles of sustainable development, but we believe that this alone will not solve the situation. For example, Kopnina (2014)<sup>335</sup>, Agbedahin (2019)<sup>336</sup> and others in their publications argued that in parallel with the information campaign there should be appropriate changes in educational programs on stakeholder requests and reflect the theoretical and practical foundations of innovative education according to Industry 4.0.

It is worth noting that today the process of reforming higher education is underway to ensure its quality. The Government adopted an order of the Cabinet of Ministers of Ukraine to attract a loan from the International Bank for Reconstruction and Development for the project «Improvement of higher education in Ukraine for results»<sup>337</sup> in 17. 03. 2021. The purpose of this project is to create conditions for improving the efficiency, quality, and transparency of higher education in Ukraine, support for systemic reforms in the field. The project consists of four interrelated components:

1) improving approaches to governance, funding, quality, and transparency in higher education by creating conditions and incentives for structural reforms. First of all, it is a question of the creation of digital space of HEIs;

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<sup>332</sup> Van Poeck, K. & Lysgaard, J. A. (2016) The roots and routes of environmental and sustainability education policy research, *Environmental Education Research*, 22 (3), 305-318.

<sup>333</sup> Lozano, R., & Barreiro-Gen, M. (2019). Analysing the factors affecting the incorporation of sustainable development into European Higher Education Institutions' curricula. *Sustainable Development*, 27 (5), 965-975.

<sup>334</sup> Zafar, M. W., Saeed, A., Zaidi, S. A. H., & Waheed, A. (2021). The linkages among natural resources, renewable energy consumption, and environmental quality: A path toward sustainable development. *Sustainable Development*, 29 (2), 353-362.

<sup>335</sup> Kopnina, H. (2014). Revisiting Education for Sustainable Development (ESD): Examining Anthropocentric Bias Through the Transition of Environmental Education to ESD. *Sustainable Development*, 22 (2), 73-83.

<sup>336</sup> Agbedahin, A. V. (2019). Sustainable development, Education for Sustainable Development, and the 2030 Agenda for Sustainable Development: Emergence, efficacy, eminence, and future. *Sustainable Development*, 27 (4), 669-680.

<sup>337</sup> Про залучення коштів позики від Міжнародного банку реконструкції та розвитку для реалізації проекту «Удосконалення вищої освіти в Україні заради результатів». Розпорядження КМ України від 17 березня 2021 р. № 201-р.

2) formation of freelance partnership alliances HEIs to increase efficiency and quality. As part of the implementation of this initiative, priority funding is provided for joint HEIs for the purchase of equipment, installation of research and training laboratories in the areas of STEM education, etc.;

3) financing the purchase of computer and multimedia equipment and software for distance learning and teaching, modern telecommunications, development of modern digital infrastructure in HEI, development and launch of electronic learning management systems, purchase of laboratory equipment for modern training and research laboratories (Research&Development) for HEIs technical profile, etc.;

4) development and financing of operational project management, its evaluation and monitoring of implementation, organization of the financial management system, preparation of reporting documents.

Given the above, scientific publications have discussed the ways to develop higher education in physics and technology to ensure its quality. The analysis of scientific publications allowed to describe the existing problems of higher physics and technics education and promising ways to solve them in the context of sustainable development of society, in particular:

1) *the development of educational programs, their implementation and control over educational activities are mainly engaged in educators, many of whom are familiar only with the theoretical side of professionally oriented activities of specialists in technical specialities.* This leads to the fact that young professionals who have just received a diploma and came to the company are familiar only with the general theory, much of which is indirectly related to their professional activities. Confirmation of this fact is that even in the List of fields of knowledge and specialities in which higher education is currently being trained, approved by the Cabinet of Ministers of Ukraine dated 29. 04. 2015, some terms are not always used correctly, including «production», «technology» and «engineering».<sup>338</sup> A thorough analysis of these concepts and an explanation of their content is reflected in the publication of A. Vdovychenko (2016)<sup>339</sup>. M. Karpash, E. Kryzhanivskiy and O. Karpash (2014)<sup>340</sup> also point to a significant weakening of technical relations with industrial enterprises. This situation, scientists emphasize, does not contribute to the realization of the target function of engineering education – preparing graduates for socially responsible engineering activities.

We believe that to solve this problem it is necessary to involve in the development of educational programs practitioners in natural sciences (including physics) and technical sciences, representatives of the economic sector and all stakeholders. As a result of such a comprehensive discussion, educational programs will be updated to take into account all aspects of future professional activities and innovative trends in education (digitalization, robotic systems, elements of artificial intelligence, 3D modelling, mechatronics, etc.);

2) *the need to strengthen the practical component in educational programs for the training of specialists in technical specialities.* Modern high-quality physics and technics education should ensure the formation of graduates of HEIs not only knowledge in a particular sector of the economy but also relevant skills that will further effectively carry out professional activities.

The list of practical activities for each educational program, their types, forms, and terms are determined by the standard of higher education (if it currently exists), curriculum and schedule of the educational process in each HEI. Analysis of educational programs of technical HEIs, in particular Vinnytsia National Technical University and Flying Academy of the National Aviation University, gives grounds to conclude that the acquisition of knowledge and skills in educational

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<sup>338</sup> Про особливості запровадження переліку галузей знань і спеціальностей, за якими здійснюється підготовка здобувачів вищої освіти. Наказ МОН від 06. 11. 2015 № 1151.

<sup>339</sup> Вдовиченко, А. І. (2016). Пошуки шляхів удосконалення системи вищої освіти в Україні. *Форум гірників - 2016: матеріали міжнар. наук.-практ. конф.*, 5-8 жовтня 2016 р. Дніпро, 2016. Т. 1. С. 248-251.

<sup>340</sup> Карпаш, М., Крижанівський Є., & Карпаш О. (2014). Вища інженерна освіта в умовах сталого розвитку суспільства. *Вища освіта України*, 2, 55-60.

programs of technical specialists does not always form a logical system. This is manifested in the following:

- there are no comprehensive practical classes aimed at solving real professionally oriented tasks;
- there is a significant gap between theory and practice. Educational programs are focused on the acquisition of theoretical knowledge. As an example, in the best universities in the world up to 70% of the educational program of bachelors, masters, Ph-doctors is devoted to the acquisition of practical skills<sup>341</sup>;
- part of the disciplines is aimed at developing the general worldview of future professionals, but they do not contribute to the formation of professional worldview, do not acquaint students with the peculiarities of a sustainable society and the importance of their future profession for economic development;
- the amount of practical training in most cases is reduced to the minimum recommended by the standard of higher education, there is often a replacement of practical training for students to stay at the department of industrial enterprise.

One of the possible solutions to this problem is the introduction of a dual form of learning. Following Part 10 of Art. 9 of the Law of Ukraine «On Education» dual form of education – a method of education that combines training of persons in educational institutions (in other subjects of educational activities) with training in the workplace at enterprises, institutions, and organizations to acquire certain qualifications usually on a contract basis<sup>342</sup>.

This form of education is not innovative for the world educational space and has proven its effectiveness. For example, in Germany, the history of dual education has a long history and aims to combine theoretical and practical approaches to learning, providing training for highly qualified professionals ready for practice, development of professional and social competencies, and sustainable development<sup>343</sup>.

3) *ensuring interdisciplinarity of higher physics and technics education*. State educational standards provide for the traditional subject principle of technical education but limit the introduction of interdisciplinary courses in the curriculum, which is one of the reasons for the fragmentary training received by graduates of technical HEIs<sup>344</sup>.

Currently, the goal of the professional activity of specialists in technical specialities is to increase the efficiency and productivity of all human activities (industrial, agricultural, medical, scientific and even political) by its technology at a higher level<sup>345</sup>.

However, at the present stage of the development of society, the product of the technical speciality is information, management decisions, actions, procedures and operations, and most of them are interdisciplinary<sup>346</sup>. Given the urgency of this issue, the Ministry of Education and Science of Ukraine has developed and approved requirements for interdisciplinary educational (scientific) programs of higher education (Order of February 1, 2021, № 128 «On approval of requirements for interdisciplinary educational (scientific) programs»<sup>347</sup>). Such interdisciplinary educational programs are actively implemented in the countries of the European Higher Education

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<sup>341</sup> Карпаш, М., Крижанівський Є., & Карпаш О. (2014). Вища інженерна освіта в умовах сталого розвитку суспільства. *Вища освіта України*, 2, 55-60.

<sup>342</sup> Про освіту. Закон України № 2145-VIII, в редакції від 21. 11. 2021

<sup>343</sup> Іщенко, Т. Д., & Чайковська, А. Б. (2020). Чи потрібно в Україні впроваджувати дуальну освіту? *Збірник матеріалів Міжнародної науково-практичної конференції «Дуальна форма здобуття освіти: успіхи та проблеми першого року запровадження пілотного проєкту у закладах фахової передвищої освіти України»*, 22 жовтня 2020 року, Науково-методичний центр ВФПО. – Київ, 2020. С. 4-9.

<sup>344</sup> Карпаш, М., Крижанівський Є., & Карпаш О. (2014). Вища інженерна освіта в умовах сталого розвитку суспільства. *Вища освіта України*, 2, 55-60.

<sup>345</sup> Шейнбаум, В. С. (2007). *Методология инженерной деятельности: учебное пособие*. Н. Новгород. 360 с.

<sup>346</sup> Маркіллі П. (2012). Третя промислова революція: цифрові технології змінять виробництво до невпізнаності. *Український тиждень*, 20 (237), 17 травня.

<sup>347</sup> Про затвердження Вимог до міждисциплінарних освітніх (наукових) програм. Наказ Міністерства освіти і науки України від 01. 02. 2021 № 128.

Area, which allows creating new professional and academic rights for applicants and helps to increase the competitiveness of the higher education system. The purpose of implementing such programs in the domestic educational space is to form learning outcomes common to a group of specialities belonging to one or two fields of knowledge and to promote the implementation of the student's conscious further choice of speciality for further study.

4) *the need for the formation of modern technical thinking in applicants for higher education in technical specialities*. Modern technical thinking is thinking not so much at the level of individual machines and mechanisms but at the level of technology (in particular, STEM-technologies, cloud-oriented technologies, ICT, etc.), which should consider the results of their impact on the environment, as well as social consequences. Professionals with such thinking are in great demand today because they are the ones who can solve issues related to the sustainable development of society.

In the conditions of the fourth industrial revolution, when there is the rapid ageing of technology and some technologies are replaced by others, technical thinking must reach a new level of development so that without additional education, the specialist can adapt to the modern man-made environment. Scientific publications define technical thinking as the psychological process by which a person traces the connections between objects and phenomena. Manifestation of technical thinking is the understanding of technology, in particular: understanding the structure of the technical device, the principle of its operation, troubleshooting<sup>348</sup>. His vision of resolving the outlined contradictions is given in the publications S. Dembitska, O. Kuzmenko (2021)<sup>349</sup>, S. Dembitska, I. Kobylanska, & S. Puhach (2020)<sup>350</sup>, та S. Dembitska, O. Kobylanskyi, T. Horokhivska, & V. Puhach (2021)<sup>351</sup>.

Thus, the 21<sup>st</sup> century is a century of global transformation and the introduction of innovative technologies. Ukraine's transition to sustainable development is almost the only way out of the current situation. The current environmental crisis is a very acute and important issue that requires swift action and decisions. Education is the main means of forming and reproducing the intellectual potential of the nation, a new system of worldview values and spirituality of citizens. One of the key tasks of education is the formation of environmental awareness, the ability to see the world in all its relationships.

The main participants in education for sustainable development are educators – the inclusion of ideas for education for sustainable development in courses and disciplines (for example, physics and technics direction), development of separate courses on sustainable development, preparation of textbooks in education for sustainable development, retraining education for sustainable development. Education for sustainable development lasts a lifetime and includes all levels and

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<sup>348</sup> Кудрявцев, Т. В. (1975). Психология технического мышления: процесс и способы решения технических задач Москва: Просвещение. 304 с.

<sup>349</sup> Dembitska, S., & Kuzmenko, O. (2021). Improvement of Self-Educational Activity of Students of Technical Specialties Based on Innovative Society Development (On The Example Of Studying Physics). *Knowledge, Education, Law, Management*, 2 (38), vol. 1., 24-30.

Dembitska, S., & Kuzmenko, O. (2021). Using Technology of Open Space as One of the Innovative Methods of Active Learning in The Training of Technical Specialities. *New impetus for the advancement of pedagogical and psychological sciences in Ukraine and EU countries: research matters: Collective monograph*. Riga, Latvia: "Baltija Publishing", 201-215.

<sup>350</sup> Дембіцька, С. В., Кобилянська І. М., & Пугач С. С. (2020). Особливості реалізації навчання впродовж життя фахівців технічних спеціальностей. *Педагогічний альманах*, 46, 117-124.

Дембіцька, С. В., Кобилянська І. М., & Пугач С. С. (2020). Реалізація міжпредметної інтеграції безпекових та фахових дисциплін в процесі підготовки фахівців економічних спеціальностей. *Сучасні інформаційні технології та інноваційні методики навчання у підготовці фахівців: методологія, теорія, досвід, проблеми: зб. наук. пр.*, 56. С. 215-222.

<sup>351</sup> Дембіцька, С. В., Кобилянський, О. В., Горохівська, Т. М., & Пугач В. М. (2021). Особливості розвитку вищої освіти в посткоронавірусному суспільстві. *Сучасні інформаційні технології та інноваційні методики навчання у підготовці фахівців: методологія, теорія, досвід, проблеми: збірник наукових праць*. Вінниця: ТОВ «Друк плюс», 62, 237-249.

categories of education and training. Thus, the educational system plays a crucial role in society, because it determines the social outline of the future of the country.

The priority tasks of sustainable development in education are the development of special education programs designed for sustainable development; introduction of pedagogical conditions, creation of models of new pedagogical culture and pedagogical content; continuous improvement of the knowledge base of subjects of education and ensuring constant awareness of the population on sustainable development.

Prospects for further scientific research are seen in the development of a model for the formation of the environmental culture of specialists in technical specialities based on sustainable development.

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