DOI https://doi.org/10.30525/978-9934-26-271-5-4

THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF THE CREATION OF AN ECO-ENVIRONMENT MODEL IN THE CONTEXT OF STEM EDUCATION: SCIENTIFIC AND EDUCATIONAL ASPECTS OF INNOVATIONS

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INTRODUCTION

The strategy of reforming higher education in Ukraine for 2022–2032 defines higher education as a factor in increasing the competitiveness of the domestic economy, the importance of ensuring the training of qualified specialists for the labor market and strengthening practical training (strengthening natural, technical and engineering components); improving the connection of higher education institutions (HEIs) with business (taking into account stakeholder requests); transformation of Ukraine's economic model into a knowledge-based economy (focusing on innovative world trends); stimulation of innovative development of education and economy; focus on creating new jobs, companies and businesses[1].

In view of the outlined directions, the updated strategy of reforming the educational sphere requires fundamentally new scientific research, the justified and consistent introduction of new scientific and pedagogical technologies, rational and effective approaches to the organization of scientific and innovative activities in education, the need to create an innovative ECO-environment to ensure high-quality teaching.

The main goal of introducing innovations into the system of higher education in Ukraine is the comprehensive development of higher education students and raising the educational level of the individual to ensure the implementation of innovative processes in Ukraine and its European choice (based on STEM technologies, 3D modelling, elements of artificial intelligence; involvement of project activities with the development of science museums to guide young people to technical and engineering disciplines)[2].

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[1] Стратегія розвитку вищої освіти в Україні на 2022-2032 рр. Розпорядження Кабінету Міністрів України від 23 лютого 2022 р. № 286-р. URL: https://mon.gov.ua/storage/app/media/news/2022/04/15/VO.plan.2022-2032/Stratehiya.rozv.VO-23.02.22.pdf

[2] Закон України «Про вищу освіту». URL: http://zakon3.rada.gov.ua/laws/show/1556-18

Currently, in Ukraine, STEM education is considered a pedagogical technology for the formation and development of soft skills in subjects of training, the level of which determines the competitiveness of an individual in the modern labour market.

Thus, STEM is a fundamental scientific method, which, together with the methodology of teaching physics and an integrative pedagogical approach to the organization of education, ensures the quality training of future specialists in the engineering and technical field in the ECO-environment. It should be noted that the basic STEM competencies are relevant at the current stage of the development of educational trends, are a priority component of the formation of the professional competence of a specialist, and are a means of implementing technology and engineering education.

1. Theoretical and methodical principles of creating an ECO-environment

Currently, there is a problem with training highly qualified and competitive specialists in the technical and engineering fields in the context of the development of STEM education. Future professions require the acquisition of professional soft skills using STEM technologies, which create conditions for finding optimal ways to interest young people in the learning process, increase their mental activity, encourage creativity, and develop scientific and research abilities. The complexity and multifaceted nature of STEM education require the participation of specialists from integrated areas of scientific research in the ECO-environment.

According to the data of the analytical report for 2020[3], Ukraine is represented in several international ratings that assess innovative potential and innovative capacity. The most authoritative are the Global Innovation Index, Bloomberg Innovation Index, Global Talent Competitiveness Index, and European Innovation Scoreboard. Ukraine's ability to master advanced technologies is assessed by the A Frontier Technologies Readiness Index, introduced by UNCTAD in 2021.

The dynamics of Ukraine's ratings according to four approaches to the assessment of innovation capacity for 2014–2020 (Fig. 1.) indicate insufficient interest in innovation policy by both the state and business.

[3] Науково-аналітична записка «Стан науково-інноваційної діяльності в Україні у 2020 році». URL: https://mon.gov.ua/storage/app/media/nauka/2021/06/23/AZ.nauka.innovatsiyi.2020-29.06.2021.pdf

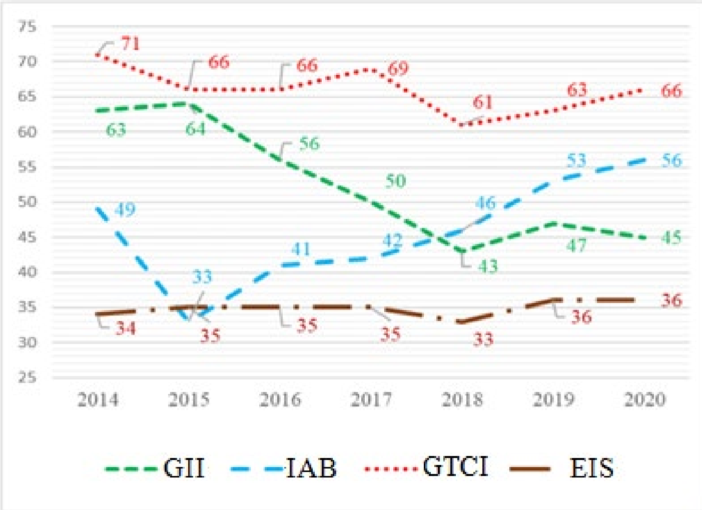

Fig. 1. Ratings of innovation trends in Ukraine: GII – Global Innovation Index; Innovation index of the Bloomberg Agency – IAB; Global Talent Competitiveness Index – GTCI; European Innovation Scoreboard – EIS (https://mon.gov.ua/storage/app/media/nauka/2021/06/23/AZ.nauka.innovatsiyi.2020-29.06.2021.pdf)

The global innovation index of Ukraine in 2020 rose by 2 positions compared to 2019, and by 26 places compared to 2013. Therefore, we note that the basis of Ukrainian innovative competitiveness is human capital and research (39th place), higher education, as well as knowledge and technological results (25th place) (Fig. 2).

According to the Bloomberg Innovation Development Index, in 2020, Ukraine took 56th place among the 60 studied countries, compared to 46th in 2018 and 53rd in 2019.

The improvement of Ukraine's position in 2020 compared to 2019 is observed only in two of the six components of the GICT index. According to the «market and regulatory opportunities» criterion, Ukraine rose by 2 positions, and according to the «talent attraction index» criterion – by 12. At the same time, the values of the following indicators worsened: the talent retention index – 73rd place against 66th in 2019, production skills employees – 56th place against 45th in 2019 (Table 1).

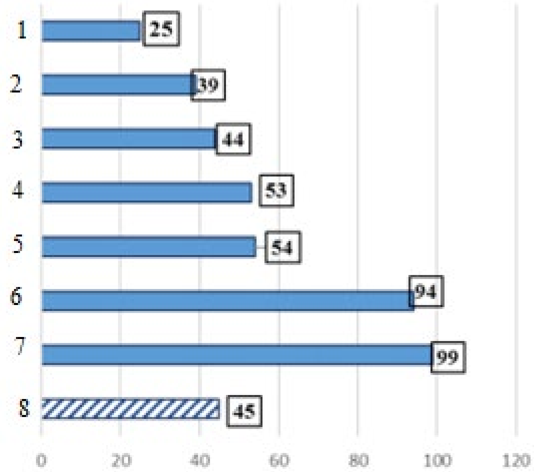

Fig. 2. Rating of Ukraine according to the indicators of the Global Innovation Index [4]: 1- knowledge and technological results; 2 – human capital and research; 3 – creative results; 4 – institutions; 5 – complexity of doing business; 6 – infrastructure; 7 – development of markets; 8 – GII

Table 1

Comparative data of the Global Competitiveness Index of Ukraine for 2018–2020 (according to URL: https://www.insead.edu/sites/default/files/assets/dept/globalindices/docs/GTCI-2020-report.pdf)

Indicator	The rating 2018	The rating 2019	The rating 2020
Talent attraction index	98	105	93
Chances for career growth	66	68	68
Talent retention index or the ability to retain qualified personnel	58	66	73
Production skills of employees	44	45	56
Global knowledge	42	37	46
Global Talent Competitiveness Index	61	63	66

The rating by the «global knowledge» component for 2018–2020 has unstable dynamics, it gradually improved by 15 positions. This was influenced by the following factors: the deterioration of the ability to

[4] Global innovation Index 2020. URL: https://www.globalinnovationindex.org/gii-2020-report.

export goods with a high added value, a decrease in the number of scientists and engineers and, accordingly, scientific research.

The European Innovation Scoreboard provides a comparative assessment of the strengths and weaknesses of the innovation systems of 27 EU member states and 10 neighbouring countries, including Ukraine. The EIT report – 2020 classifies Ukraine among the countries of «slow innovators» (outsiders) – countries that demonstrate an efficiency level below 50% of the EU average. According to the general innovation index of the EIT (36% in 2019-2020), Ukraine is at the level of Romania and inferior to Bulgaria, Montenegro and North Macedonia (Fig. 3).

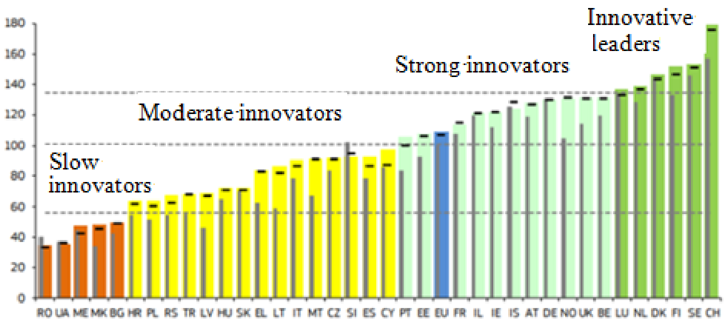

Fig. 3. Training of innovators in the countries of the world[5]

Thus, the need for innovation is more relevant today than ever before, which is connected with the need to restore the economy of Ukraine, and innovation can become an effective means of achieving this goal with the change in the ways of functioning of the economy and society as a result of modern technological transformations in the conditions of development Industries 4.0. (implementation of artificial intelligence technologies, blockchain, industrial Internet of Things, STEM education technologies: 3-D printing, 5G communication, augmented and virtual reality, etc.), which fundamentally change the processes of logistics, learning and knowledge accumulation, and the formation of STEM competencies.

One of the directions of the innovative development of science and mathematics education is the STEM education system, thanks to which subjects of education develop logical thinking and technical literacy, learn to solve problems, and become innovators, and inventors. STEM

[5] European innovation scoreboard 2020. URL: https://ec.europa.eu/docsroom/documents/42981)

education will strengthen and solve the most pressing problems of the future. The proposed model of the ECO-environment (Fig. 4) considers the relationship of science, STEM education, innovation and business outlined by us (taking into account the requests of stakeholders).

According to this, the transfer of educational STEM innovations from the level of theoretical knowledge in the process of teaching physics and professionally oriented disciplines to the level of their productive use is possible if the technology for their implementation is developed. It is the level of implementation of STEM technologies in the teaching methodology of physics that is an indicator of relevance and effectiveness, which is manifested in new qualitative results of the educational process in physics.

In a generalized form, the problem of modernizing the educational process from the direction of innovative provision and technology as an element of STEM education should be implemented by systematic activity, design, expertise and monitoring in the educational organization. We consider the concept of innovation to be the result of such activity on the implementation of STEM technologies, which contributes to quantitative and qualitative changes in the level of development of soft skills of education seekers. It is defined in the works of V. Bespalka, O. Dakhin, D. Jones, V. Dokuchaev, V. Zagvyazynskyi, H. Mkrtychyan, C. Polyakov, A. Khutorskyi, V. Yasvin, and others.

The technologization of innovative processes using STEM education in the ECO-environment is an appropriate response to the growth of their complexity in terms of volume, the number of subjects of innovations, factors, and connections, and it is also necessary for the simultaneous combination of the implementation of various innovations in the methodology of teaching physics based on STEM-technologies.

Scientist A. Prigozhin notes that «efficiency will be at a high price for a long time, and technology is an indisputable source of it, as it produces the antagonist of complexity – simplification»[6].

Technologization is an activity to optimize processes or activities, in our research – innovative ones. According to the scientist, it is possible to outline the following advantages and qualities of technology[7].

– rationality, which makes it possible to save time, energy, force, resources, etc;

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[6] Пригожин А. И. Методы развития организаций. Москва : МЦФЭР, 2003. С. 366.

[7] Там само. С. 367.

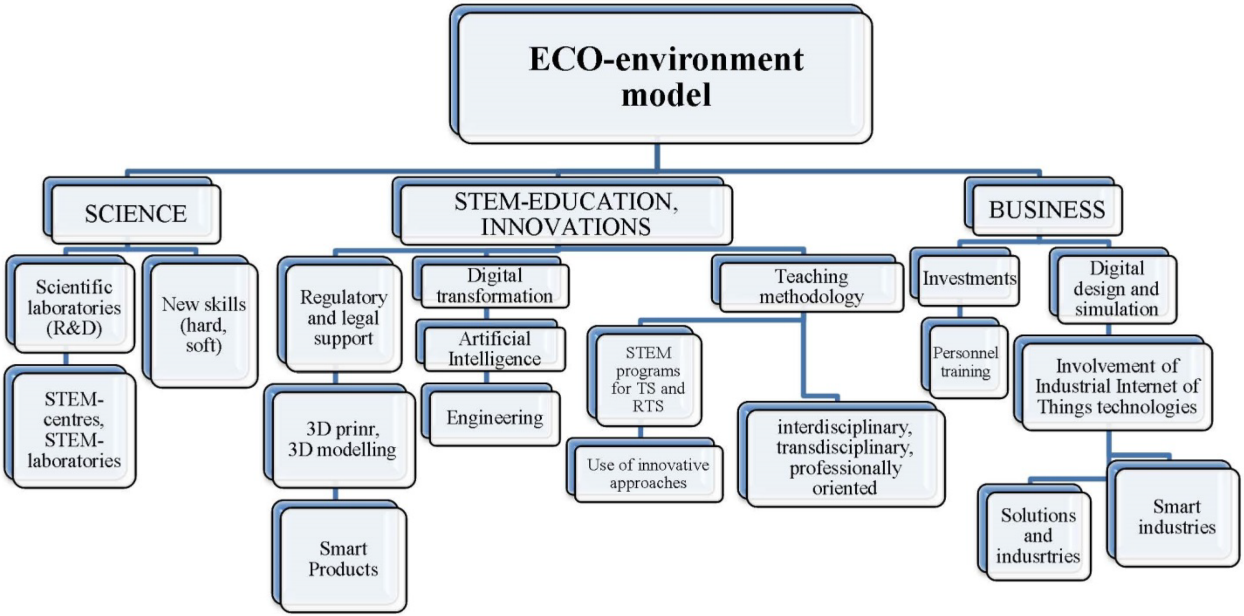

Fig. 4. Hierarchy of the structure of the ECO-environment in the context of STEM education

– depersonalization, that is, independence from the personal qualities of the employee, because the variety of individualities will be narrowed in a certain way, reduced to some single, but relative denominator, during the execution of technological procedures;

– replication – the possibility of transferring to others, using these same technologies in the process of replacing people, therefore the technology is a mastered, replicated project.

According to H. Gerasimov and L. Ilyukhin[8], at different stages of the life cycle, innovations form their mechanisms that can solve this or the objectivity of action with the appropriate logic.

At the first stage of innovation development, the logic of movement from the «new» idea to the model of its optimal implementation is observed in the form of «innovation» as content and «innovation» as a certain way of influencing the system qualities of the object and innovation.

In the second stage, the direct implementation of the previously formulated constructs unfolds, therefore, its content consists of the logic of a qualitative change in the system.

The specificity of the third, final (in the interpretation of the authors), stage of innovation implementation is that it consists of two rather independent phases: the first is the initiation of innovative changes in a different scale of activity; the second is innovative changes themselves as a reproduction of innovation in new conditions. Such a structure of the third stage can be explained, on the one hand, by the laws of diffusion of innovation in the socio-cultural space, on the other hand, by the necessary expansion of innovation, which ensures its further development.

The dialectic of the innovation process is ensured by the interaction of all objects and subjects and the mutually determined and mutually beneficial symbiosis of modernization and requirements for technology through innovation, innovation management, models of innovations and their phasing by means of finding, forming, implementing and securing innovations. From the above, we will single out the *theoretical and methodological principles of creating an ECO-environment model, taking into account the methodology of teaching physical and technical disciplines in higher education institutions based on STEM technologies*, which will ensure an increase in the effectiveness of independent educational and research activities of education seekers:

1. High-quality conscious assimilation of the theoretical and practical foundations of physics by the subjects of education, taking into account STEM technologies, will provide a well-founded mathematization,

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[8] Герасимов Г. И., Илюхина Л. В. Инновации в образовании: сущность и социальные механизмы. Ростов н/Д : Логос, 1999. 136 с.

technologization, and innovation of the educational process of technical higher education, which contributes to the formation of a competent specialist of a technical profile in an innovative ECO-environment.

2. Transdisciplinary, integrative, interdisciplinary, systemic and professionally oriented approaches to the process of teaching physics and technics disciplines in HEIs involve a change of views on the essence and purpose of the physics experiment system in the ECO-environment, the creation of modern equipment, the use of STEM kits taking into account individual characteristics, abilities, inclinations of each subject of study, with the expansion of the scope of experimental tasks, works of a physical workshop based on STEM-technologies of education.

3. The successful formation of a competent specialist in the conditions of the ECO-environment, taking into account digital technologies, will ensure the theoretical and methodological training of the next-generation education seeker, which involves the introduction of innovative technological directions and compliance with the didactic principles of scientificity, clarity, accessibility and defined pedagogical conditions, depth, integrity, universality, a fundamental basis updated in the context of STEM education.

4. The use of a system of psychological and pedagogical influences in the ECO-environment, which is aimed at forming the readiness to search, create, implement and consolidate effective and efficient innovations in the educational process of physics and professionally oriented disciplines with the introduction of computer technologies, STEM education, mechatronics, robotics.

5. Ensuring the systematic study and implementation in the educational process of the results of scientific achievements in the physical and technical disciplines of higher educational institutions, transformed to the requirements of the principles of didactics, thanks to the creation of an effective educational and scientific ECO-environment with the ideology of STEM education, which activates the independent cognitive and research activities of those seeking education and formation they have a natural and scientific outlook.

6. Development of a mechanism for the implementation of digitalization in physics education, which creates a need for the formulation of scientific and pedagogical requirements for STEM-means of education in physics and technics disciplines for higher education, robotics and mechatronics. This will strengthen the role of theoretical knowledge in the teaching of physics and professionally oriented disciplines, will give it priority in the formation of a competent future specialist, will contribute to the realization of potential opportunities

for activating the cognitive activity of subjects of education based on STEM technologies.

7. The creation of an effective system of teaching physics and technics disciplines in higher education institutions will to a large extent ensure the formation of algorithmic, visual and theoretical thinking styles of students, the development of them of the ability to optimize decision-making in a difficult situation, quickly process information using data analysis systems, information-search systems, databases based on the educational and scientific ECO-environment.

The identified principles provide grounds to introduce an innovative process of teaching physics and technics disciplines in higher education institutions based on STEM technologies and to define specific technological tasks to ensure:

– conceptual design of technology for the implementation of STEM innovations in physics and professionally oriented disciplines;

– clear forecasting of the goals of the innovation and guaranteed achievement of the results of the innovative activity of education seekers in the process of learning physics and professionally oriented disciplines using STEM technologies;

– formation of the volume and sequence of actions and operations important for obtaining the predicted results by students of physics education;

– standardization of the learning process, which reduces the number of operations, reduces the time and costs of training teachers, ensures the avoidance of spontaneous and erroneous actions, and unjustified attempts at mastering STEM innovations in physics and professionally oriented disciplines;

– finding effective forms of interaction between the subjects of innovations in the educational process of physics and professionally oriented disciplines, taking into account modern trends in the development of STEM education;

– reduction of deadlines for certain stages and operations of the educational process in physics and professionally oriented disciplines using STEM technologies;

– specification of the actions of each of the performers, coordination of interaction, and reduction of their efforts during the assimilation of new forms of activity in the educational process of physics and professionally oriented disciplines in the context of STEM education;

– activation of feedback channels during innovations for effective management of the educational process in physics and professionally oriented disciplines based on STEM technologies;

– creating opportunities for changing the algorithm of actions, simplifying or complicating operations by changing the conditions for the implementation of STEM innovations, increasing the innovative potential of technical higher education institutions, and increasing the technological competence of education seekers in learning physics and professionally oriented disciplines in the ECO-environment.

The above makes it possible to assert that it is important to take into account the individual characteristics of the students of education in the well-founded theoretical and methodological foundations of creating an ECO-environment model for higher education institutions based on STEM technologies.

The process of implementing STEM innovations in the teaching of physics and professionally oriented disciplines ensures the practical use of the pedagogical system and making changes to it, which helps to bring it to such a level of functioning that will help to obtain qualitatively new sustainable results of activity and determine the innovative potential of innovations in the ECO-environment.

2. ECO-environment of the Junior Academy of Sciences of Ukraine in the context of the development and implementation of a STEM-oriented interactive science museum

The United Nations Environment Programme (UNEP), which was created in 1972 after the Stockholm Conference of the United Nations on the Environment, is its main body in the field of environmental protection and is designed to provide leadership and promote cooperation in the interests of the environment by stimulating activities, informing and providing assistance to improve the quality of life. UNEP's activities cover a wide range of issues and problems related to the environment and sustainable development, among which, in the context of our research, such areas as technology transfer and industry and conservation of natural resources are the most relevant[9].

It should be noted that since 2005, the National Center «Junior Academy of Sciences of Ukraine» (hereafter National Center «JANU») has been a domestic leader in the development of STEM education (these are the first hackathons and startups, scientific schools with Nobel laureates, international competitions of young geniuses, scientific projects in robotics and the organization of an all-Ukrainian contest for projects of young researchers, field research expeditions and projects of CERN, ANL, NASA, with which the Small Academy of Sciences

[9] Програма ООН з навколишнього середовища (ЮНЕП). URL: https://mepr.gov.ua/content/programa-oon-z-navkolishnogo-seredovishcha-yunep.html

cooperates, etc.). And for all time one of the priorities in this work remains the focus on scientific innovations and environmental safety.

In this context, the activities of the National Center «Junior Academy of Sciences of Ukraine» cover a significant number of ECO areas. First of all, it is that the work of scientific sections and branches of the National Academy of Sciences (Fig. 5) is focused on preserving the environment, creating new technological developments and modern ecological products, and improving the quality of life. When determining the value of the scientific and research works of the people of Maniv, a significant emphasis is placed on the ecological component and the preservation of natural resources. Also, in the structure of 12 scientific departments and 63 scientific sections, the department of «Ecology and Agrarian Sciences», represented by 6 sections, occupies a worthy place (Fig. 5)[10].

Secondly, the first state interactive science museum opened in 2020, which we present as a STEM-educational project of the National Academy of Sciences and where it is forbidden not to touch the exhibits, where the most important technological achievements of mankind, scientific laws and their interaction are demonstrated in an understandable and accessible form, also has an ECO-orientation and orientation on the safety of visiting children.

All scientific instruments and exhibits of the museum were purchased thanks to the cooperation of the Small Academy of Sciences of Ukraine with the International Association of Science and Technology Centers (ASTC). The museum has exhibits from the USA, Canada, Great Britain, Sweden and Poland and other leading world manufacturers of similar experimental equipment, which are ecologically and physically safe.

For example, the Strange Matter zone from Canada talks about the properties of materials. Here it is allowed to do everything that will help to explore them: touch, move, poke and hit. And even check the strength of the glass by throwing a bowling ball into it! In the exhibition space, visitors are also waiting for: a two-meter hologram from Great Britain – there are only two such in the whole world; a square-wheeled bicycle from the Museum of Mathematics in New York; an interactive table with a 3D model of the human body, brought from Sweden, and more than 100 interactive exhibits[11].

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[10] Мала академія наук України. URL: https://mon.gov.ua/ua/osvita/pozashkilna-osvita/derzhavni-centri-pozashkilnoyi-osviti/mala-akademiya-nauk-ukrayini

[11] П’ять причин відвідати музей науки на ВДНГ. URL: https://nv.ua/ukr/kyiv/kudi-piti-v-kiyevi-muzey-nauki-na-vdng-shcho-divitisya-novini-kiyeva-50111226.html

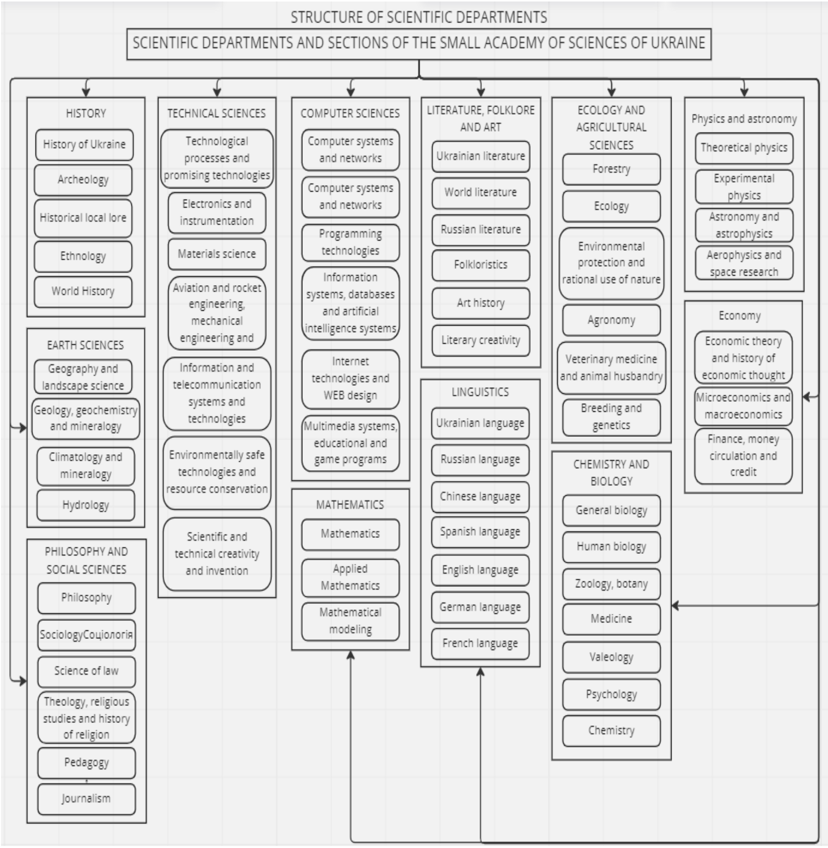

Fig. 5 Structure of scientific departments of the Junior Academy of Sciences of Ukraine

Also, among the exhibits of the museum, there are a number of devices that allow you to get closer to modelling ecological processes. One of these devices is an interactive sandbox – an augmented reality exhibit that creates a projection on real sand that is sensitive to human movements (Fig. 6). The depth sensor measures the distance to the real sand, and the program processes the data received from the sensor, and the projector displays various virtual objects. With its help, participants can explore the terrain and climatic conditions of the Earth and independently build a volcano or flood a city. Picking up a small plastic ring, you become the mistress of the desert or mountains, collect clouds and cause lightning. The process is so exciting that some stay at the table for a long time. Children are focused on nature, and the coolest thing is that no one prevents them from studying the exhibits and processes as much as they are interested[12].

Fig. 6. Interactive sandbox – an exhibit of augmented reality

Thirdly, a very important resource conservation component is that the Interactive Museum uses equipment such as interactive tables that replace and preserve a large number of live research objects. These are touch panels with instant touch response. The main purpose of the device is 3D visualization of real data at the level of bones, muscles, nervous system and gases. The following topics are presented on the tablets for visitors: human anatomy, animals, insects and meteorites in cross-section[13] (Fig. 7).

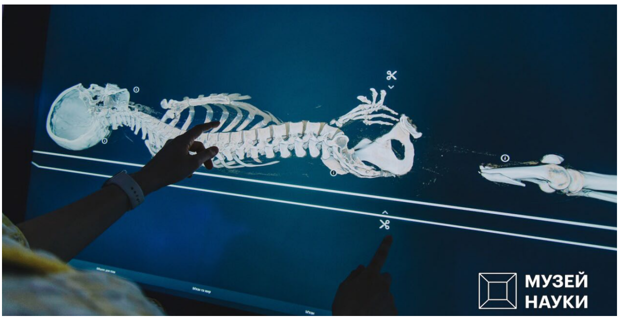

Fig. 7. Interactive table of the Museum of Science

Also in the museum, for the development of research competencies, without which STEM education is unthinkable, safe research technological equipment made of environmentally friendly materials for children is used (fig. 8).

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[12] Про музей науки. URL: https://sciencemuseum.com.ua/ua/about-us/pid/2

[13] Про музей. URL: https://sciencemuseum.com.ua/ua/about-us/pid/2

Fig. 8. Safe research equipment of the Interactive Science Museum of the Junior Academy of Sciences

In conclusion, I would like to emphasize the role of interactive museums in the STEM education system, where they provide maximum visibility, the opportunity to study the laws of science in the game, disassemble and collect exhibits, and have the presence of extremely interesting devices and equipment that allow you to visualize the most famous scientific experiments. In these museum spaces, there are no old clichés regarding the presentation of educational material, which are replaced by the use of a wide range of interactive pedagogical methods and tools that interest children in independent research, encourage the desire to participate in research, try to put forward their hypothesis and get a practical scientific experience-result.

Orientation to different age groups of children, different levels of knowledge of visitors, and scientific preferences affect the brightness, effectiveness, emotionality, unusualness of scientific expositions and installations, technical know-how and high-tech exhibits – all that leaves memories in the child's memory for a long time and makes him return to gain more scientific knowledge. In this STEM system, unusual guides work – interpreters, or explainers of phenomena, who have appropriate training to ensure a high level of safety for the visiting child.

In this ECO-STEM envinronment of the science museum, designed with the comfort and safety of an interactive environment in mind, there is a place for research, mobile games, children's communication, reading literature, excursions, and science show programs. Parents trust the high level of safety of children's life activities.

Also, in the STEM education system of the National Center «JANU» in the context of the implementation of environmental protection approaches, environmental protection, and the availability of electronic knowledge depositories for the students of the National Center «JANU», a virtual STEM center JANlab was created, which increases media literacy and the number of visitors per month is more than 15-20 000 online visits[14].

Our time is a time of genius crisis – when technology companies lack qualified STEM specialists, who are today the most popular and most in demand on the global labour market. And to prepare the relevant professions of the future, it is necessary to invest as much as possible in the development of STEM education.

Therefore, solving problems related to the development of cognitive, research, and technological competencies of the future scientific change acquires extreme relevance in the conditions of globalization and Ukraine's orientation towards innovative technological, economic, and environmental development.

Fig. 9. JANlab virtual STEM center

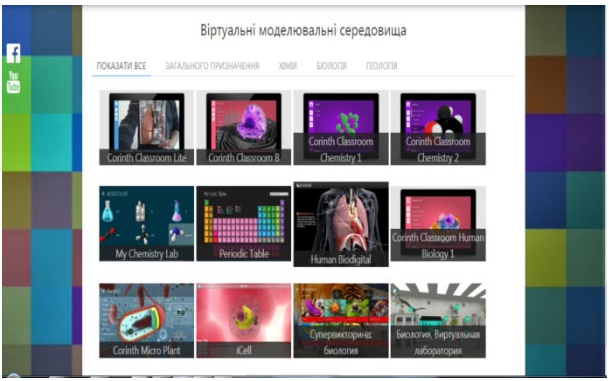

Fig. 10. Virtual simulation environments of the virtual STEM center

[14] Віртуальний STEM-центр Малої академії наук України. URL: http://stemua.science

Fig. 11. Video lectures of the virtual STEM center

CONCLUSIONS

In the modern conditions of improvement of physics education, the process of familiarizing subjects of education with the basics of physics and technics disciplines is impossible without the wide implementation of STEM-technologies and the use of means of their implementation in the ECO-environment. Taking into account innovative trends and the main directions of improvement of the educational process based on STEM-technologies[15], a method of teaching physics and technics disciplines has been created for effective training of education seekers with fundamental cross-cutting generating concepts.

Such a method should develop and stimulate interest in knowledge and understanding of physics, their application in explaining the phenomena and processes of the microcosm and the surrounding world as a whole, and give students an effective system of knowledge, abilities and skills, and form a natural-scientific worldview, which is reflected in our proposed ECO model – environments.

In the process of designing an innovative ECO-environment of educational institutions (on the example of the National Center «Junior Academy of Sciences of Ukraine»), we pay attention to the compliance of its components, structure and functioning with general pedagogical principles that should be taken into account in any pedagogical systems.

[15] Kuz'menko O., Sadovyi N. Physics. Mechanics. Molecular Physics and Thermodynamics, Electromagnetism. Oscillations and wave optics. Quantum and atomic physics. Kropivnitskiy : KFA NAU, 2017. 324 p.

The application of the principle of fundamentalization of the teaching of physici and technici disciplines (the example of the Museum of Science) is significant, which provides for the acquisition of a system of knowledge in subjects of a new generation of education, which possess the properties of depth, integrity, universality, have a fundamental basis, are updated in the conditions of the development of innovative education, taking into account development trends modern education.

Thus, the innovative ECO-environment significantly increases the freedom of choice and experimentation with various types of STEM tools, namely: electronic resources, software, computer platforms and technologies, expands the share of the research approach in teaching physics and technics disciplines, promotes the development of skills joint processing and analysis of data and results of a collective study of physics phenomena and processes.

SUMMARY

In the research, the justification and development of the theoretical and methodological foundations of the creation of an ECO-environment in the conditions of the development of STEM-education. As a result of the research, the main directions of innovations in the educational activity of HEIs in the context of the development of innovations, in particular STEM education, in Ukraine were identified and analyzed, namely: humanization, humanitarianization, differentiation, diversification, standardization, multi-level, fundamentalization, informatization, individualization, continuity (on the example of the Museum of Science).

It has been established that a change in the field of education, in particular engineering and technical, taking into account the development of STEM education, involves a review of the concept of training specialists in each specific field of activity, therefore, the modernization of the content of education requires updating the teaching methodology (goals, content, methods, forms and means), through which, in the future, the implementation of modern innovative STEM approaches will be carried out in the conditions of the ECO-environment.

There was a need to create a modern model of an innovative ECO-environment that would satisfy the level of knowledge both for studying special disciplines and in professional activities. The need to create an innovative ECO-environment is substantiated; determined its place, main elements and structure, established the main properties of the ECO-environment based on STEM-technologies, which will ensure the improvement of the quality of the formation of soft skills of subjects of education taking into account digital technologies.

Therefore, the training of subjects of technical specialities based on STEM-technologies in educational institutions in the conditions of the ECO-environment needs modernization following the modern achievements of physical science and didactic principles of building a physics course, taking into account fundamentality, scientificity, continuity and interdisciplinary connections. Therefore, the modernization of higher education in Ukraine should take into account the general trends in the development of education systems in the context of globalization and European integration processes, namely taking into account the trends in the development of STEM-education.

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