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FORMATION OF A GENDER-SENSITIVE ENVIRONMENT IN THE INNOVATIVE TRANSFORMATION OF THE SCIENTIFIC AND EDUCATIONAL SPACE: THE ASPECT OF STEM EDUCATION

Abstract. *In the conditions of martial law, the creation of a gender-sensitive environment in higher education institutions based on STEM is an urgent task. An important task of science and education at the moment is to provide favourable conditions for the subjects of education based on the state's innovation policy (for example, STEM, artificial intelligence, robotics, etc.), as well as to provide feedback between the student and the teacher. Activation of the problem of the gender component, focusing attention on the concept of zero tolerance in the system of training personnel from the economic profile and developing a new methodology for building a gender-sensitive environment in this field will ensure the integrity of the process of forming intellectual potential among women and men, is the main goal of the author's research. This is aimed at the rationality of the organization of the training of education seekers taking into account gender aspects on the basis of STEM. In the research, the authors outlined contextual levels and contradictions regarding the formation of a gender-sensitive environment, in particular: the context of the needs for social order (taking into account the equality of rights of women and men); the context of needs for science (pedagogical, engineering, technical, legal, physical and mathematical disciplines), taking into account transdisciplinarity and aspects of STEM education; in the context of the needs of pedagogical practice (development and implementation of innovative approaches in a gender-sensitive environment in the context of the formation of soft skills of subjects of education capable of implementing STEM technologies in the educational process). The purpose of the research is scientific substantiation, conceptualization and development of a gender-sensitive environment for institutions of higher education based on STEM. The object of research is the educational process in institutions of higher education. The subject of the research is the theoretical and methodological substantiation of the expediency of the formation and development of a gender-sensitive environment of a higher education institution based on STEM education.*

Keywords: *STEM education, gender-sensitive environment, STEM technologies, institutions of higher education, soft skills, the aspect of physical and mathematical direction.*

Problem statement in general and its connection with important scientific or practical tasks. Taking into account the dangerous situation today, the urgent issue and the main tasks of science and education are the preservation of life, the values acquired by mankind during it's existence and the provision of appropriate safe conditions for those acquiring education, which determines the need for the formation of a gender-sensitive environment in institutions of higher education (hereinafter —

IofHE) taking into account innovative trends (for example, STEM education, virtual reality, high-precision positioning technologies, "SMART" business cards, artificial intelligence, etc.).

The gender aspect of ensuring high-quality education of students in physics, mathematics and vocational disciplines, creating effective conditions for remote communication with students of education and STEM-technologies, mobile applications has gained considerable relevance at the present time. Today, more than ever, the task of activating digital technologies in the context of gender policy in higher education (hereinafter — HE) and providing dynamic improvement and development of the methodology for building a gender-sensitive environment based on STEM-education is emerging. This will ensure the integrity of the process of formation and support of the state's intellectual potential at a high level.

The concept of the research is that the physics, mathematics and vocational training of future specialists in engineering, technical, and economic fields in IofHE is the foundation for the further formation of soft skills in the students of education, which is important for the future competitive specialist, his readiness for the appropriate type professional activity taking into account the development of STEM-education. These aspects are relevant when they will be implemented in a gender-sensitive environment, which is currently a very important aspect of the innovation-educational-scientific space of Ukraine.

An analysis of recent research and publications that have begun to address this issue. According to UN [1] analytical data on gender equality policy for STEM specialities, we note that 24 % to 33 % of women are involved. The relevance of the direction of STEM education in Ukraine is gaining an important aspect, and we note that the involvement of girls in physics, mathematics and engineering disciplines is increasing every year.

Thus, in Ukraine, there is a growing demand for the training of highly qualified specialists with transdisciplinarity skills and the ability to work in the field of IT- and STEM-technologies.

Leading scientists García-Holgado A., García-Peñalvo F. J. substantiated the W-STEM (women in STEM) model, in which the educational and scientific process is considered with various tools aimed at the attraction, access and leadership of women in the institution of higher education (hereinafter — HEIs). The work process consists of four stages (see *Fig. 1*) [2]:

- the first stage considers the analysis of the situation (tasks for verification and self-assessment, focused on reflection and insight);
- the second phase is defined by the Gender Equality Action Plan (GEAP) to define the strategy and goals and develop actions to achieve them in Latin American HEIs;
- the third phase covers the implementation of the measures defined in the Action Plan on Gender Equality;
- the fourth stage considers the processes that ensure compliance with the goals set in the GEAP. It implements mechanisms to measure the impact and achievement of objectives, and the results are used to update the GEAP or improve the implementation of actions.

Important aspects of gender equality are outlined in the work of Ballatore M. G., Borger J. D., Misiewicz J. and Tabacco A. [3], regarding the study of gender differences in the self-perception of higher education graduates regarding the choice of a profession, in particular STEM.

The research of gender stereotypes in the IT field is considered in Borsotti V. [4], which reveals empirical research on socio-cultural barriers to the participation of women in software development projects at the University of Information Technology in Copenhagen.

Scientists Kang J., Hense J., Scheersoi A., Keinonen T. [5] emphasize the importance of preventing stereotypes and inconsistent models in teachers, focusing on future career prospects. The results of the study show that non-inclusive language, the choice of heteronormative educational material and communication style can leave part of the student body out of context, especially girls.

Research by leading scientists Nguyen U. and Riegle-Crumb C. [6] indicates that the cause of the gender gap is not biology, innate traits that can differentiate people by gender, or specific components of what occupations people should pursue according to their gender.

Therefore, the gender gap in STEM fields is a global problem, which is caused by various factors, as revealed in research [7; 8; 9; 10], where the impact of stereotypes on learning in higher education institutions and the obstacles and barriers that cause segregation are considered.

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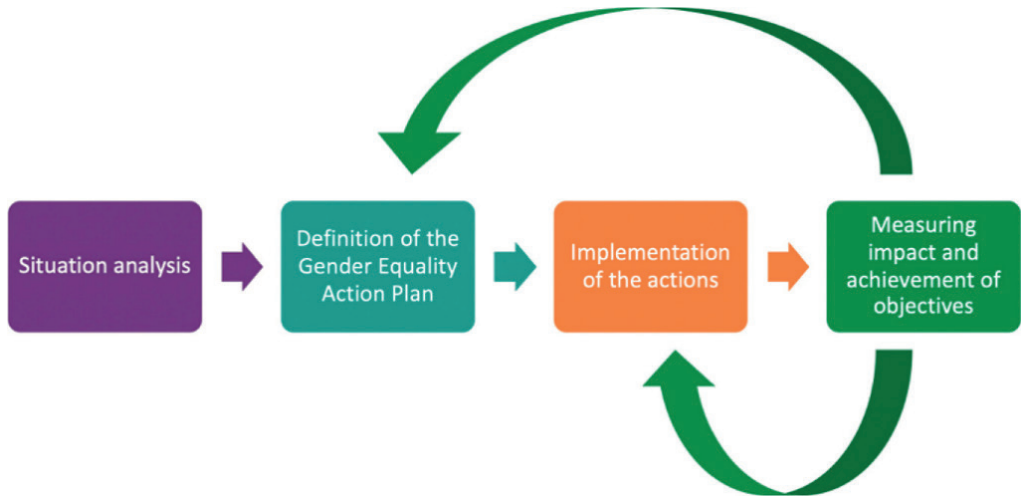

Fig. 1. W-STEM model in Hihher Educational Institutions in Latin America [2]

Taking into account the above the leading idea of the research is that the physics-mathematics and professional-technical training based on STEM-technologies in IofHE, which is based on the principles of the unity of fundamentalization, transdisciplinarity, systematicity and gender equality, ensures the readiness of the subjects of training to obtain a quality education in physics and mathematics and professional-technical activities. Professions with knowledge of STEM-technologies are valuable in their world, however, they are undervalued in Ukraine.

In our research, concepts were formed regarding the creation of a gender-sensitive environment for students of higher education based on STEM-education:

- *the methodological concept* reveals the systemic interrelationship and interaction of transdisciplinarity, systematicity, fundamentalization and gender equality to solve the problem of integration of teaching physics, mathematics and professional technical disciplines in a gender-sensitive environment in IofHE;
- *the theoretical concept* defines a system of basic legal provisions, the latest scientific and crosscutting concepts, which are fundamental for understanding gender equality on the basis of STEM education in the teaching of physics and mathematics and vocational-technical disciplines in IofHE; peculiarities of the cognitive and search activity of education seekers in a gender-sensitive environment on the basis of STEM-education; professional qualifications for innovative gender activities, key professional competencies for gender-oriented training; professional STEM skills;
- *the methodological concept* involves the development, substantiation and description of the methodological foundations and teaching methods of physical, mathematical and professional technical disciplines based on STEM technologies, determination of the stages of their transdisciplinarity, implementation in practice of teaching physics, mathematics and professional technical disciplines in conditions of a gender-sensitive environment in IofHE.

In particular, in the theoretical-practical and methodical aspects of teaching physics-mathematics and professional-technical disciplines based on STEM education, attention should be paid to the following tasks:

- creating a model of a gender-sensitive environment based on STEM education;
- substantiation of the theoretical and methodical principles of teaching physics-mathematics and professional-technical disciplines for students of HE based on STEM-technologies;
- development of teaching methods for physics-mathematics and professional-technical disciplines for higher education graduates in the conditions of STEM-education.

The direction of our scientific research is related to the topic of research work “Implementation of innovative technologies in the process of teaching physics and mathematics disciplines in the conditions of the development of STEM-

education" (state registration №. 0117U000789); "Creation of an innovative educational and scientific STEM-environment for teaching physics and mathematics disciplines based on the ontological approach in the conditions of a digital agent" (state registration number 0121U100279); with research-experimental work of the All-Ukrainian level on the topic "Scientific-methodical foundations of the creation and functioning of the All-Ukrainian scientific-methodical virtual STEM center" (Order of the Ministry of Education and Science of Ukraine № 708 dated 05.17.2017).

The research goal is scientific substantiation, conceptualization and development of a gender-sensitive environment for institutions of higher education based on STEM education.

The object of research is the educational process in institutions of higher education.

The subject of the research is the theoretical and methodological substantiation of the expediency of the formation and development of a gender-sensitive environment of IofHE based on STEM-education.

Thus, the fundamental provision of training of education seekers using STEM-technologies, in particular in a gender-sensitive environment, will become more effective in conditions of transdisciplinarity and systematicity.

STEM-education is a factor in the development of an innovative educational and scientific environment in educational institutions of various profiles. The strategy of reforming higher education in Ukraine until 2020 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 labour market and strengthening practical training; improvement of the connection of IofHE with business; transformation of Ukraine's economic model into a knowledge-based economy; stimulation of innovative development of education and economy; focus on creating new jobs, companies and businesses; consideration of gender equality in the educational and scientific space of IofHE [11].

During the war in Ukraine, innovations and new approaches in educational practice became especially relevant, as it is now necessary to make quick, non-standard decisions. The creation of a comfortable educational environment in which the principles of gender equality are provided for Ukraine during the war is of great importance, especially for persons who have suffered psychological trauma, the educational process should be interesting and contain the essence of cognitive and emotional support. The leading institutions of Ukraine (the Institute of Digitization of Education, the Institute of education content modernization, the National Center "Junior Academy of Sciences of Ukraine", the Institute of the Gifted Child of the National Academy of Sciences of Ukraine and the Institute of Pedagogy of the National Academy of Sciences of Ukraine) developed distance learning programs, paying attention to digitalization education and innovative educational projects, in particular "National Educational Technopark", "Intellect of Ukraine", "Technology of teaching students of the primary school "Smart Kids" (Smart-Kids)", creation of an all-Ukrainian scientific and methodical virtual STEM center, etc.

In the 21st century an inseparable component of the development of the methodology of teaching physics-mathematics and professional-technical disciplines in technical IofHE is innovation — objects of implementation or a process that contributes to the emergence of something new — innovation [12], in particular STEM-education, which reflects transdisciplinarity between four components (sciences, technologies, engineering and mathematics).

In our opinion, the results of the scientific investigations of the above-mentioned researchers [13; 14] reflect the progressive movement of education in Ukraine from the position of a post-industrial society, which can be characterized by the phenomenon — "innovative social educational and scientific organization of the 21st century" (*Fig. 2*)

According to scientists, this phenomenon of the XXI century is explained by the inevitability of fundamental changes in the processes and procedures of scientific and technological development, taking into account gender equality.

In Fig. 2 the reasons and regularities of the emergence of such an arrangement and its new structure, which determines all changes in science and education, are presented, in particular, as a solution to the contradictions that arose in the 90s of the XX century.

Considering the analysis of the content of the components of order, modern science has practically unlimited possibilities for the conquest of the universe by man. Along with science, through interaction with practice (industry, agriculture),

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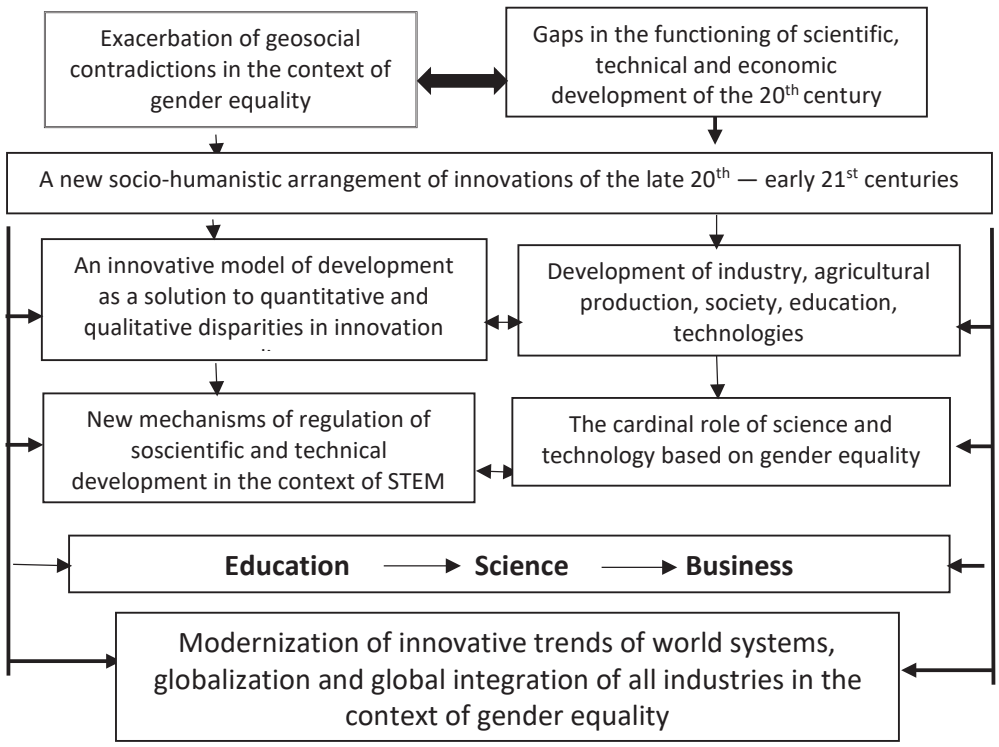

Fig. 2. Innovative social educational and scientific organization of the 21st century

technologies also develop. Evolutionarily, the development of science is generally different from the development of technology. Historically, since its inception, science had unrelated fields of knowledge scattered in natural philosophy. After the first industrial revolution, the unification of scientific disciplines into larger specialized associations, their differentiation: interdisciplinarity, cross-disciplinarity, transdisciplinarity, etc.

The development of engineering and technology over a long period of time contributed to important discoveries, the progress of a separate industry, and then the system of industries, and their integration. Thanks to the acceleration of science and technology, the market economy has practically penetrated into all areas of society, it is possible to observe the intersection in time of a number of waves of the scientific and technical revolution, the generation of new mechanisms for regulating socio-economic and scientific and technical development, the modernization of the leading economic and social systems of the world, globalization and world integration of all fields, in particular science and education, but there is always an anticipatory development of the latest knowledge in relation to technology.

According to the model of the interaction of notification and servicing processes (sources of resources) in the chain of "science — innovative infrastructure — an innovative system of IofHE" [15], innovativeness is a defining characteristic of any modern processes, namely: scientific and technical, production, socio-economic, social. The transition to the innovative development of HE has a decisive socio-economic and humanistic significance since the main attention belongs to the processes of transforming a person from an agent of scientific, technical and social progress to his real subject, the deployment of a person's creative potential and its realization [15].

Comparative research of the components of the global competitiveness index (Global Competitiveness Index) of Ukraine according to the data of the World Economic Forum for 2019–2020 confirms that Ukraine ranks 81st out of 137 countries, the highest place in which the component of HE in Ukraine is 35th place among 137 countries of the world [16].

One of the innovations in modern global education is STEM. We consider the main essence of the STEM concept, STEM competencies, and STEM-technologies as a means of teaching physics.

STEM-education forms a complex of certain qualities for the acquirer / acquirer of education, namely: critical thinking, creativity skills, teamwork, engineering and programming abilities. Achieving the corresponding goal in teaching physics, mathematics and professional technical disciplines can be achieved by integrating STEM-disciplines through interdisciplinary education and research activities [17, pp. 16–33], which requires the introduction of new methodological approaches and STEM-tools in their teaching methods.

Justification of the creation of a gender-sensitive environment based on STEM-education. Ensuring the innovative orientation of education should be carried out by creating innovative educational structures taking into account gender equality, reforming the education system taking into account the requirements of European standards and preserving cultural and intellectual national traditions, implementing educational programs aimed at fostering creative thinking and a positive attitude towards innovations (use of STEM-technologies).

Innovation according to the interpretation of I. Bohdanova according to the principle of innovative potential [18]: improvements related to modification, rationalization, and modernization; radical innovations related to the transformation of the traditional system into an alternative one; complex innovations covering elements of improvement and transformation.

In our research, we will identify the signs of *innovations that are characterized by their scale in the education system and the innovativeness of their potential*: 1) at the macro level, the transformation of innovations takes place, which leads to radical changes and conditions the renewal of the entire system; 2) at the meso level, staffing takes place according to the main directions of interrelated innovations in each component of the education system: preschool, general secondary, extracurricular, professional, higher education, postgraduate; 3) improvement, i. e., modernization, modification, and rationalization of the traditional pedagogical process take place at the micro level, which determines the locality or singularity of unrelated innovations, i. e., changes that lead to elemental modifications.

The dynamics of changes in the admission of subjects of study according to the directions of STEM education are shown in figure 3, which shows the percentage of study subjects in Ukraine who chose technical and engineering disciplines during 2007–2015. The average decrease in admissions for STEM education has decreased by 25% in recent years [12; 19]. This is because the majority of applicants have low knowledge of physics and choose other subjects to confirm the quality of their knowledge for admission to technical IofHE.

In general, at the beginning of the 2020/2021 academic year, 1,141,900 people studied in IofHE, of which 53.2% were women. Accordingly, the index of gender parity among students of universities, academies and institutes were 1.135. The highest values of the index were observed

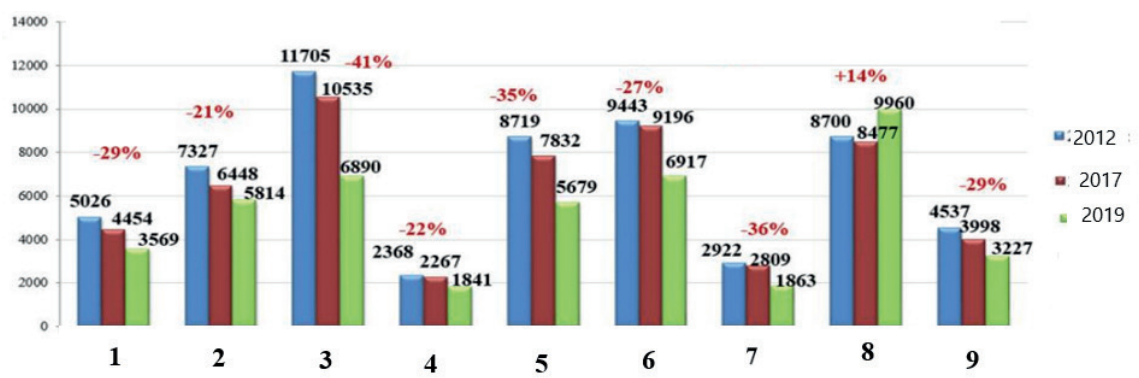

Fig. 3. Dynamics of admission of study subjects to physics, mathematics and engineering and technical specialities of IofHE in the areas of STEM-education: *1* — Energy; *2* — Electronics; *3* — Natural and physics sciences; *4* — Mineral development and surveying; *5* — Mechanical engineering and metallurgy; *6* — Agricultural production; *7* — Transport and Construction; *8* — IT sphere; *9* — Chemical and biotechnology [12]

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for such areas of training30 as journalism (4.166), humanities (4.009), biology (3.893), culture and art (3.040), social work (3.440), health care (2.864), service (2.740) and education/pedagogy (2,550).

According to the list of 2015, approved by the Resolution of the Cabinet of Ministers of Ukraine dated April 29, 2015, No. 266 "On approval of the list of fields of knowledge and specialities for which higher education candidates are trained" of the gender parity index are typical for such areas of training as electrical and mechanical engineering (0.100 and 0.113, respectively), electronics and telecommunications (0.145), automation and instrumentation (0.162), and transport (0.164). Compared to the 2016/2017 academic year, the distribution of women among students in the following fields of knowledge has changed significantly: law (from 46.8% in 2016/2017 to 56.4% in 2020/2021); maths and statistics (from 44.9% to 39.5%, respectively); civil security (from 25.8% to 44.4%).

At the same time, experts predict an increase in the number of graduates in STEM-education by 2020 [19], which is due to an integrated approach to teaching physics and professional disciplines using modern teaching tools (3-D printers, educational robotics, artificial intelligence, etc.). The types of innovations based on the relationship to tradition are as follows: renewal of goals, the content of education, methods, means, technologies, forms of organization, styles of the pedagogical activity, and management of the pedagogical process.

STEM-education was covered in their scientific research by a glossary of the main terms of STEM-education was outlined by scientist N. Honcharova [20]; aspects of interdisciplinarity and transdisciplinarity are defined in the scientific works of O. Stryzhak [21]; professor I. Slipukhina [22] established the didactic features of STEM education, etc.

Achieving pedagogical goals is possible only in the conditions of functioning of the appropriate environment. The definition of "environment" is diverse in its interpretation.

The academic explanatory dictionary of the Ukrainian language [23] defines the environment is 1) matter, bodies that fill some space and have certain properties; 2) sphere; 3) a set of natural conditions in which the vital activity of any organism takes place; 4) social and domestic conditions in which a person lives; environment; 5) a set of people connected by common living conditions, occupations, and interests.

The encyclopedic dictionary [24] interprets the concept of "environment" as the social, material, and spiritual conditions of a person's life and activity. The environment in a broad sense (macroenvironment) covers the economy, public institutions, public consciousness and culture. The social environment in the narrow sense (microenvironment) includes a person's immediate environment — family, work, education and other groups.

Consider the educational and training environment.

D. Kostyukevich considers the educational environment as an organized environment, the components of which are designed to contribute to the achievement of the goals of the educational process [25].

In particular for our research identified the following main types of educational environments:

1) dogmatic educational environment — promotes the development of passivity and dependence of the subject of learning on the reproductive level of mental activity in classes, in particular, physics;

2) career educational environment — promotes the development of the student's activity and dependence on the subjective and objective influence on the motivation of studying a subject;

3) carefree educational environment — promotes free development and conditions the passive life position of the subject of education about real reality;

4) creative educational environment — promotes the free and motivated development of an active subject of learning to acquire subject competence.

When creating a high-quality modern educational environment in physics, several ambiguities arise, the elimination of which can contribute to targeted research in this direction. In particular, researchers A. Gurzhii, Y. Zhuk, V. Volynskyi [26] note that to increase the effectiveness of the process of forming an educational environment, it is necessary to fulfil the following requirements, which we take into account when creating a STEM-environment:

- improvement of the material and technical base of institutions of higher education in the technical field of reseach;

- development of organizational and pedagogical prerequisites for the effective use of teaching aids, including modern information and communication aids and digital equipment;
- development of methods of effective use of STEM-learning tools;
- the creation of a reliable delivery system for STEM learning tools and necessary equipment in the process of teaching physics;
- the creation of an information bank of data on the development and implementation of STEM-means of technology in the process of teaching natural and scientific disciplines in institutions of higher education of a technical direction;
- the creation of a financing program for the development of modern STEM tools.

In connection with the global trend towards the development of cloud technologies, artificial intelligence, 3-D and 4-D printing, and virtual reality, demand for specialists in these fields is expected in 2023 [27; 28].

More and more heads of educational institutions (vocational education, higher education) and innovative centers of IofEH are aware of the need for such knowledge, and most importantly, they are looking for additional funding (grants, project activities) to provide STEM-learning tools.

On this basis, the specific pedagogical goals of forming a gender-sensitive environment based on STEM-education for IofHE are outlined:

1) development of the creative potential of those who study; development of abilities for communicative actions; development of experimental and research skills, which is an integral part of the development of STEM education;

2) intensification of the educational process in IofHE, increasing its efficiency and quality in teaching physics, mathematics and vocational-technical disciplines based on STEM-education;

3) implementation of a social order conditioned by the information of modern society, gender equality in this subject area and training of users using STEM-education.

Thus, summarizing the analysis of research by leading scientists, they do not single out the concept of a gender-sensitive environment based on STEM education (*Fig. 4*).

In our opinion, a gender-sensitive environment includes the following components: simulation (educational physics experiment, cloud technologies), professional and transdisciplinary components and STEM-methods. The gender approach in HE should pass through all institutional levels and be based on the principles of fundamentalization, gender equality and a professional-oriented approach. Let's consider the individual components of our proposed model of a gender-sensitive environment based on STEM-education:

- modelling — a method of scientific knowledge, that considers the structure and study of models of real objects and phenomena from physics, mathematics and professional-technical disciplines (mathematical modelling, the model and the original have different physical nature and are described by the same mathematical equations);
- a physics experiment allows you to observe the results given by the initial conditions. A real experiment does not always allow for obtaining all the data of the process under investigation. In the context of the introduction of modern STEM-technologies and information and communication technologies into the educational process of IofHE, the model experiment becomes important;
- a model experiment is used when a real physics experiment is difficult or impossible to set up. The combination of model computer and real experiments allows us to: demonstrate the physics phenomena being studied, thereby creating the necessary experimental base for their study, illustrate the laws and regularities established in science in a form accessible to the subjects of education, make their content understandable, to increase visibility in learning phenomena and processes, which in turn will ensure the comprehensive formation of a gender-sensitive environment on the basis of STEM-education;
- cloud technologies we consider such as models that allow fast search, processing, operational use and storage of information. In our study, the term "cloud" is understood as a source of information, a server, a network where data and programs are stored, connecting the user via the Internet to any access point.
- professional training of a qualified specialist is an integral component of a gender-sensitive environment based on STEM-education, as the subject of study who acquires a physical and mathematical or engineering and technical education must obtain the final result, namely:

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- to be able to find non-standard, effective solutions to scientific, industrial, social and other problems, relying on basic theoretical knowledge and on obtaining practical skills of personal research activities in the teaching of physical, mathematical and professional-technical disciplines;
- to feel the need for constant, systematic replenishment and updating of acquired knowledge in physics, engineering, and technical direction, without stopping the process of self-improvement, self-education and self-study throughout life;
- to rethink and apply the necessary information from various sources in practical activities.

The transdisciplinary component is considered in the process of studying individual topics, sections, natural and scientific disciplines, in particular physics and disciplines of the professional field of study, reflecting the scientific, engineering and mathematical component of STEM-education, in particular taking into account gender equality.

The components of a gender-sensitive environment on the basis of STEM-education are interdependent, systemically united and determined general goals of the educational process of higher education. A change in the quality of these components causes a change in the quality of the gender-sensitive environment.

The structure of the gender-sensitive environment proposed by us based on STEM-education (Figure 4) depends on the psychological and

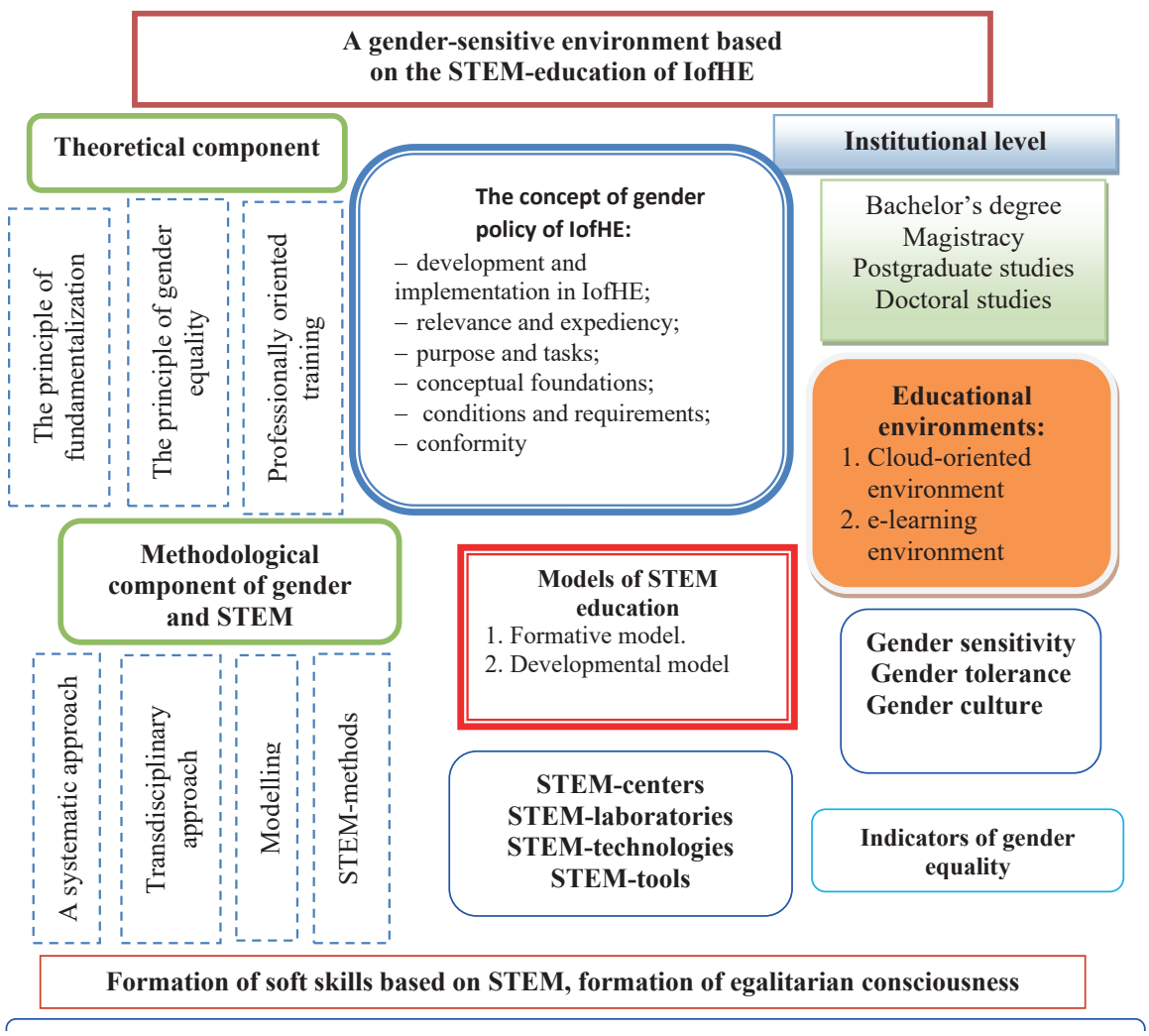

Fig. 4. A model of a gender-sensitive environment based on STEM-education

pedagogical factors of its use in the educational process of HEIs, namely:

1) motivation of the purposefulness of learning physical, mathematical and professional technical disciplines, provided that the subject of education is fully formed regarding the purpose of the experiment, stimulation of cognitive activity aimed at achieving the set goal based on STEM-technologies;

2) compliance with the didactic principles of transparency regarding methods and forms of experimental presentation of educational material in classes on physical and mathematical and professionally oriented disciplines based on STEM-technologies;

3) individualization of the learning process when performing a physical experiment based on STEM education technologies, which is based on transdisciplinary and systemic approaches;

4) ensuring openness in the selection of STEM tools for conducting a physical experiment;

5) creation of constant feedback between subjects of training, which makes it impossible to make mistakes when performing physical practice works using STEM-technologies;

6) the formation of new STEM skills, which involves the use of educational tools that should be aimed at the development of logical thinking.

The analysis of selected factors showed new qualities of the components of a gender-sensitive environment on the basis of STEM-education due to new qualities of the education system as a whole. For example, the use of transdisciplinary learning methods and relevant STEM tools helps students to develop extracurricular competencies: the ability to use communication tools, enter data into a computer, recognize messages generated by computerized systems, communicate with team members, formulate and prove for the information of fellow judges. They are important components of the general culture of a citizen of a digital society. It should also be noted here the depth of the problem and the differences between the gender-sensitive environment on the basis of STEM-education in rural and urban areas, but this issue is a separate research.

So, we outlined the concepts of the environment, the educational environment and identified a gender-sensitive environment on the basis of STEM-education, determined their place, main elements and structure, established the main psychological and pedagogical factors to ensure the improvement of the quality of the formation of STEM skills, subjects of study taking into account modern trends in the development of physics and mathematics and vocational-technical education, taking into account gender equality.

Conclusions and prospects for further explorations in this direction. Thus, the analysis of scientific and practical experience on the problem of creating a gender-sensitive environment based on STEM education in higher education institutions made it possible to state that:

- the modern level of scientific and technical progress increases the importance of science, engineering, and technical components in the training of specialists based on STEM-education technologies, which requires: a transfer of the teaching process of physics-mathematics and professional-technical disciplines of HE to a much higher level, especially with the use of STEM-learning technologies to support and organize the cognitive and research activities of education seekers, taking into account the gender approach. The use of STEM-technologies as a means of learning in the teaching methodology of physics, mathematics and professional technical disciplines with a combination of transdisciplinary, systemic and professionally oriented approaches allows strengthening the professional orientation of the training of future HE specialists at a new level;
- taking into account the importance of fundamentalization as a didactic principle of designing the teaching content of physics and mathematics disciplines and vocational-technical disciplines in IofHE from the perspective of the paradigm of STEM-education, transdisciplinary, systemic and professionally oriented approaches and the fundamentalization of the content of physics teaching, the theoretical and methodological principles of teaching are substantiated taking into account approach of gender equality based on STEM-education technologies;
- a model of a gender-sensitive environment based on the principles of STEM-education has been created, which will increase the level of knowledge of students in the process of learning physics, mathematics and professional-technical disciplines. The formation of a gender-sensitive environment based on the principles of STEM-education is because such an environment

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is a special means of forming the executive, search and creative abilities of education seekers, as well as a tool for performing managerial functions to achieve the goals of physics, mathematics and vocational education;

- in the process of ascertaining the stage of pedagogical research, the presence of identified contradictions, summarized in the introduction, was confirmed, which gave grounds for the formation of the theoretical and methodological foundations of teaching physics and mathematics and professional-technical disciplinary principles of STEM-education with the training of highly qualified specialists in HE, which ensures the activation of cognitive activity education recipients taking into account gender equality. It was determined that the intellectualization of knowledge and technologies motivates the youth of the new generation to master the knowledge and STEM-technologies in the context of a gender approach;
- the results of the conducted comparative experiment to identify the effectiveness of the proposed method of teaching physics based on STEM-technologies showed that the level of formation of physics knowledge, abilities and skills of students in the control groups is lower than the corresponding level in the experimental groups. The critical value χ^2 determined according to the table for the level of significance accepted in pedagogical research is $\alpha = 0,05$; $\chi^2_{cr} = 12,59$, $\chi_{ex} = 13,3$ i. e. $\chi^2_{ex} > \chi^2_{cr}$ and based on the Kolmohorov — Smirnov criterion leads to the conclusion, $T_{об} > W_{1-a}$ i. e. (0.035 > 0.0003), that is why the developed method of studying physics, mathematics and engineering-technical disciplines based on STEM-technologies is more effective than the existing one.

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ФОРМУВАННЯ ГЕНДЕРНО ЧУТЛИВОГО СЕРЕДОВИЩА В ІННОВАЦІЙНІЙ ТРАНСФОРМАЦІЇ НАУКОВО-ОСВІТНЬОГО ПРОСТОРУ: АСПЕКТ STEM-ОСВІТИ

***Анотація**. В умовах воєнного стану створення гендерно чутливого середовища в закладах вищої освіти на основі STEM є актуальним завданням. Важливим аспектом науки та освіти на цей момент є створення сприятливих умов для суб'єктів навчання на основі інноваційної політики держави (наприклад, STEM, штучний інтелект, робототехніка тощо), а також забезпечення зворотного зв'язку між здобувачем вищої освіти і викладачем. Активізація проблеми гендерної складової, акцентування уваги на концепції нульової толерантності в системі підготовки кадрів економічного профілю та розроблення нової методології побудови гендерно чутливого середовища в цій сфері забезпечать цілісність процесу формування інтелектуального потенціалу жінок і чоловіків, що є основною метою авторського дослідження. Це спрямовано на раціональність організації навчання здобувачів освіти в закладах вищої освіти з урахуванням гендерних аспектів на основі STEM. У дослідженні автори окреслили контекстуальні рівні та протиріччя щодо формування гендерно чутливого середовища, зокрема: контекст потреб суспільного устрою (з урахуванням рівності прав жінок і чоловіків); контекст потреб у науці (педагогічні, інженерні, технічні, юридичні, фізико-математичні дисципліни) з урахуванням трансдисциплінарності та аспектів STEM-освіти; контекст потреб педагогічної практики (розроблення та впровадження інноваційних підходів у гендерно чутливому середовищі стосовно формування soft skills суб'єктів освіти, здатних впроваджувати STEM-технології в освітній процес). Метою дослідження є наукове обґрунтування, концептуалізація та розвиток гендерно чутливого середовища закладів вищої освіти на основі STEM. Об'єктом дослідження є освітній процес у закладах вищої освіти. Предметом дослідження є теоретико-методологічне обґрунтування доцільності формування та розвитку гендерно чутливого середовища закладу вищої освіти на основі STEM.*

***Ключові слова:** гендерно чутливе середовище, STEM-технології, заклади вищої освіти, soft skills, аспект фізико-математичного напряму.*

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