8. Mistry K. Yonezawa E. Milne N. Paediatric Physiotherapy curriculum: an audit and survey of Australian entry-level Physiotherapy programs. BMC Med Educ. 2019: 19 (109): DOI: https://doi: 10.1186/s12909-019-1540-z.

9. Киричук В.О., Руденко С.А. Проектування та психолого - педагогічний супровід розвитку обдарованістю-Монографія-Київ- 2012.- 272 с.

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FORMATION OF A GENDER-SENSITIVE ENVIRONMENT BASED ON STEAM EDUCATION: THE ASPECT OF TRANSDISCIPLINARYNESS

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.

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

ФОРМУВАННЯ ГЕНДЕРНО-ЧУТЛИВОГО СЕРЕДОВИЩА НА ЗАСАДАХ STEAM-ОСВІТИ: АСПЕКТ ТРАНСДИСЦИПЛІНАРНОСТІ

В умовах воєнного стану створення гендерно-чутливого середовища у закладах вищої освіти на основі STEAM-технологій є актуальною проблемою. Важливим завданням науки та освіти на даний момент є створення сприятливих умов для суб'єктів освіти на основі інноваційної політики держави (наприклад, STEAM, штучний інтелект, робототехніка тощо), а також забезпечення зворотного зв'язку між здобувачем вищої освіти та викладачем. Активізація проблеми гендерної складової, акцентування уваги на концепції нульової толерантності в системі

підготовки кадрів економічного профілю та розробка нової методології побудови гендерно-чутливого середовища в цій сфері забезпечить цілісність процесу формування інтелектуального потенціалу жінок і чоловіків, є основною метою авторського дослідження. Це спрямовано на раціональність організації навчання здобувачів освіти з урахуванням гендерних аспектів на основі STEAM.

Ключові слова: гендерно-чутливе середовище; STEAM-технології; заклади вищої освіти; м'які навички; аспект фізико-математичного спрямування.

According to UN [1] analytical data on gender equality policy for STEAM specialities, we note that 24% to 33% of women are involved. The relevance of the direction of STEAM 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 STEAM-technologies.

Leading scientists García-Holgado A., García-Peñalvo F. J. substantiated the W-STEAM (women in STEAM) 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 Figure 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 STEAM.

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.

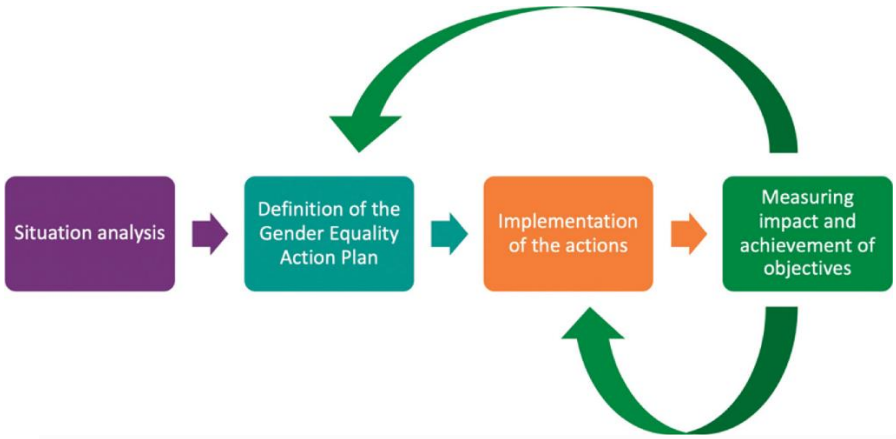

Figure 1. W-STEAM model in Higher Educational Institutions in Latin America [2]

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 STEAM 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.

Taking into account the above the leading idea of the research is that the physics-mathematics and professional-technical training based on STEAM-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 STEAM-technologies are valuable in their world, however, they are undervalued in Ukraine.

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

– creating a model of a gender-sensitive environment based on STEAM education;

– substantiation of the theoretical and methodical principles of teaching physics-mathematics and professional-technical disciplines for students of HE based on STEAM-technologies;

– development of teaching methods for physics-mathematics and professional-technical disciplines for higher education graduates in the conditions of STEAM-education.

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

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

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 [11], in particular STEAM-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 [12; 13] 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» (Figure 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 Figure 1 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), 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.

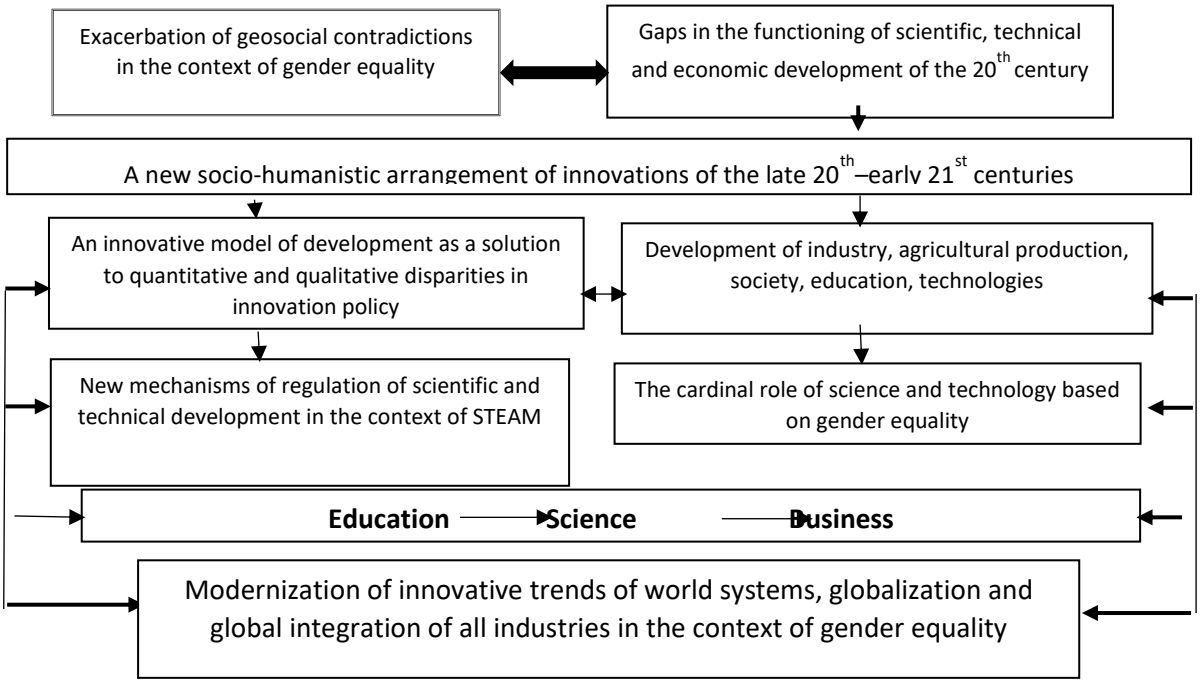

Figure 2. Innovative social educational and scientific organization of the 21st century

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» [13], 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 [14].

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.

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

STEAM-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 STEAM-disciplines through interdisciplinary education

and research activities [14, p. 16–33], which requires the introduction of new methodological approaches and STEAM-tools in their teaching methods.

Thus, the analysis of scientific and practical experience on the problem of creating a gender-sensitive environment based on STEAM 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 STEAM-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 STEAM-learning technologies to support and organize the cognitive and research activities of education seekers, taking into account the gender approach. The use of STEAM-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 STEAM-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 STEAM-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 STEAM-education is because such an environment 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.

References:

1. The Global Gender Gap Report. 2018. Jan. 2024. URL: http://reports.weforum.org/global-gender-gap-report-2018 (in English).

2. García-Holgado, A., García-Peñalvo, F.J. A Model for Bridging the Gender Gap in STEM in Higher Education Institutions. In: García-Peñalvo, F.J., García-Holgado, A., Dominguez, A., Pascual, J. (eds) Women in STEM in Higher Education. *Lecture Notes in Educational Technology*. Springer, Singapore. 2022. Pp. 1–19. 2022. Jan. 2024, doi:https://doi.org/10.1007/978-981-19-1552-9_1 (in English).

3. Ballatore, M. G., Borger, J. D., Misiewicz, J., & Tabacco, A. ANNA tool: A way to connect future and past students in STEM. *IEEE Revista Iberoamericana*

De Tecnologias Del Aprendizaje, *15*(4), pp. 344–351. 2020. Jan. 2024, doi: https://doi.org/10.1109/RITA.2020.3033231. (in English).

4. Borsotti, V. Barriers to gender diversity in software development education: Actionable insights from a danish case study. 40th ACM/IEEE International Conference on Software Engineering: Software Engineering Education and Training, ICSE-SEET 2018; Gothenburg; Sweden; 30 May 2018 through 1 June *2018*, pp. 146–152. 2018. Jan. 2024, doi: https://doi.org/10.1145/3183377.3183390 (in English).

5. Kang, J., Hense, J., Scheersoi, A., & Keinonen, T. Gender study on the relationships between science interest and future career perspectives. *International Journal of Science Education*, *41*(1), pp. 80–101. 2019. Jan. 2024, doi:https://doi.org/10.1080/09500693.2018.1534021 (in English).

6. Nguyen, U., & Riegle-Crumb, C. Who is a scientist? The relationship between counter-stereotypical beliefs about scientists and the STEM major intentions of Black and Latinx male and female students. *International Journal of STEM Education*, *8*(1). 2021. Jan. 2024, doi: https://doi.org/10.1186/s40594-021-00288-x (in English).

7. Cadaret, M. C., Hartung, P. J., Subich, L. M., & Weigold, I. K. Stereotype threat as a barrier to women entering engineering careers. *Journal of Vocational Behavior*, *99*, pp. 40–51. 2017. Jan. 2024, doi:https://doi.org/10.1016/j.jvb.2016.12.002 (in English).

8. García-Holgado, A., Vázquez-Ingelmo, A., Verdugo-Castro, S., González, C. S., Sánchez-Gómez, M. C., & García-Peñalvo, F. J. Actions to promote diversity in engineering studies: A case study in a Computer Science Degree. En *2019 IEEE Global Engineering Education Conference (EDUCON), (9–11 April 2019, Dubai, UAE)*. IEEE. 2019. Jan. 2024, doi: https://doi.org/10.1109/EDUCON.2019.8725134 (in English).

9. García-Holgado, A., González-González, C. S., & Peixoto, A. A comparative study on the support in engineering courses: A case study in Brazil and Spain. *EEE Access: Practical Innovations, Open Solutions*, Volume *8*, pp. 125179–125190. 2020. Jan. 2024, doi: https://doi.org/10.1109/ACCESS.2020.3007711 (in English).

10. Makarova, E., Aeschlimann, B., & Herzog, W. The gender gap in STEM fields: The impact of the gender stereotype of math and science on secondary students' career aspirations [Original research]. *Frontiers in Education*. 2019. *4*(60). Jan. 2024, doi: https://doi.org/10.3389/feduc.2019.00060 (in English).

11. The foresight of the economy of Ukraine: medium-term (2015–2020) and long-term (2020–2030) time horizons / Sci. project manager academician NAS of Ukraine M.Z. Zgurovskyi. International Council for Science (ICSU); System Analysis Committee at the Presidium of the National Academy of Sciences of Ukraine; National Technical University of Ukraine «Kyiv Polytechnic Institute»; Institute of Applied System Analysis of the National Academy of Sciences of Ukraine and the Ministry of Education and Science of Ukraine; World Data Center for Geoinformatics

and Sustainable Development. 2015. Kyiv: NTUU KPI. Jan. 2024, Available: http://wdc.org.ua/en/node/182604 (in Ukrainian).

12. Paranee Chomphuphra, Pawat Chaipidech and Chokchai Yuenyong. Trends and Research Issues of STEM Education: A Review of Academic Publications from 2007 to 2017. Journal of Physics: Conference Series, Volume 1340, International Annual Meeting on STEM Education (I AM STEM) 2018. Pp 13–15. August 2018, Avani Khon Kaen Hotel, Thailand. Jan. 2024, doi: https://doi.org/ 10.1088/1742-6596/1340/1/012069 (in English).

13. Kuzmenko, O., Dembitska, S., Miastkovska, M., Savchenko, I., & Demianenko, V. Onto-oriented Information Systems for Teaching Physics and Technical Disciplines by STEM-environment. International Journal of Engineering Pedagogy (iJEP), 13 (2), Pp. 139–146. 2023. Jan. 2024. doi: https://doi.org/10.3991/ijep.v13i2.36245. (in English).

14. The Global Competitiveness Report 2017–2018 WEF. [Online]. Jan. 2024, Available: https://www.weforum.org/reports/the-global-competitiveness-report-2017-2018/ (in English).

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ОСОБЛИВОСТІ РЕАЛІЗАЦІЇ ІНТЕГРОВАНОГО ПІДХОДУ ТА ВИДИ НАВЧАЛЬНОЇ ІНТЕГРАЦІЇ STEAM

У статті проаналізовані деякі особливості інтегрованого підходу до навчання STEAM, показано деякі важливі компоненти дисциплінарної і міждисциплінарної педагогічної практики STEAM, що впливають на її ефективність. Подано авторську модель, яка поєднує різні види інтеграції та показано їхні можливості для вирішення різноманітних завдань STEM/STEAM-освіти

Ключові слова: інтеграція мистецтва і STEAM, розвиток креативності, моделі інтеграції в STEAM

This article analyzes some features of the integrated approach to STEAM learning. The most important components of disciplinary and interdisciplinary pedagogical practice that affect its effectiveness are shown. The author's model is presented, which combines various types of integration and shows their possibilities for solving various tasks of STEM/STEAM education

Keywords: integration of art and STEAM, development of creativity, models of integration in STEAM

STEAM є акронімом для п’яти різних предметних галузей – природничі науки, технології, інженерії, математики і мистецтва, кожна з яких має свої