сукупності методологічних підходів, системи напрямів евристично-інноваційної діяльності. Наслідком впливу історично-антропологічних концепцій є утворення у ході навчального процесу таких інтелектуально-професійних властивостей особистості, як стимулювання ширини мислення індивідууму, створення системного розуміння реальності, генерування творчого характеру вирішення завдань у науковій, інженерній, підприємницькій і управлінській діяльності.

ЛІТЕРАТУРА:

1. Айтов С.Ш. Теоретичні особливості історично-антропологічної версії сучасної філософії історії. Дослідження з історії і філософії науки і техніки. 2025. Випуск 34 (2). С. 18-28.
2. Agresta A. Plague Correspondence, Rumour, and Mistrust in the Late Medieval Crown of Aragon. Past & Present. 2025. vol. 259. iss. 1. P. 15–45.
3. Armstrong-Partida M., McDonough M. Singlewomen in the Late Medieval Mediterranean Arrow. Past & Present. 2023. vol. 269. iss. 1. P. 3–42.
4. Hailwood M. Time and Work in Rural England, 1500–1700. Past & Present. 2020. vol. 248. iss. 1. P. 87–121.
5. Taylor B. Solitude and Soul in Restoration. Britain. Past & Present. 2024. vol. 262. iss. 1. P.84–132.

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THE IMPACT OF STEAM EDUCATION ON LEARNERS' COGNITIVE DEVELOPMENT: AN ANALYSIS OF GLOBAL PRACTICES

Анотація. Розвиток і підготовка здобувачів освіти безпосередньо впливають на майбутнє науки, економіки та сталого освітнього прогресу країни. Залучення здобувачів освіти до практик STEAM, що поєднують природничі науки, технології, інженерію, мистецтво та математику, відіграє

важливу роль у формуванні ключових компетентностей сучасного світу, зокрема комунікативних навичок, здатності до співпраці, інноваційного мислення та критичного аналізу. STEAM-підхід сприяє підвищенню зацікавленості у навчанні, трансформуючи теоретичні знання у практично орієнтовану діяльність і дослідницький досвід. Він також забезпечує розвиток адаптивності до швидких технологічних змін сучасного світу. В Україні цей освітній напрям набуває дедалі більшого поширення та інтегрується навіть на рівні початкової освіти.

В нашій роботі були проаналізовані провідні міжнародні практики STEAM-освіти та узагальнені ключові висновки щодо актуальних дослідницьких аспектів у цій сфері.

Ключові слова: STEAM-освіта, освітній прогрес, інноваційне мислення, критичний аналіз, міжнародний досвід.

Abstract. The development and training of learners directly influence the future of science, the economy, and the country's sustainable educational progress. The engagement of learners in STEAM practices, which integrate science, technology, engineering, arts, and mathematics, plays a crucial role in developing key competencies of the modern world, including communication skills, the ability to collaborate, innovative thinking, and critical analysis. The STEAM approach enhances students' interest in learning by transforming theoretical knowledge into practice-oriented activities and research-based experiences. It also fosters adaptability to the rapid technological changes of the modern world. In Ukraine, this educational approach is gaining increasing momentum and is being integrated even at the level of primary education.

In our study, leading international STEAM education practices were analyzed, and key conclusions regarding current research issues in this field were summarized.

Keywords: STEAM education, educational progress, innovative thinking, critical analysis, international experience.

Within the framework of United Nations Sustainable Development Goal 4 (SDG 4), which outlines priorities for the period up to 2030, ensuring high-quality education is recognized as a central component of sustainable educational development [1]. In this context, collaborative inquiry-based learning, along with the cultivation of critical thinking and problem-solving abilities, plays a pivotal role in advancing sustainable educational practices [2].

Among contemporary pedagogical approaches, Science-Technology-Engineering-Arts-Mathematics (STEAM) education – an interdisciplinary model integrating science, technology, engineering, arts, and mathematics has gained increasing attention [3]. This approach emphasizes continuous inquiry, active collaboration, and experiential learning, thereby supporting students in developing competencies essential for lifelong learning [4].

Furthermore, STEAM-oriented programs expand educational opportunities by fostering engagement across diverse formal and informal learning environments.

Through sustained emphasis on collaboration and inquiry, these programs encourage learners to continuously develop their skills and adapt to evolving educational and societal demands [5].

In a study by Trültzsch-Wijnen et al. (Austria, Lithuania, Romania, 2022), researchers investigated the incorporation of robotics into contemporary educational systems. The findings demonstrated that the implementation of STEAM-based technologies is actively supported through national educational policies and strategic initiatives. Moreover, these approaches facilitate the enhancement of children's digital literacy, problem-solving abilities, and computational thinking skills [6].

In the study by Kalaitzidou et al. (Greece, 2023), researchers systematized the robotic tools commonly applied within STEAM education. The authors examined various categories of educational robotics and evaluated their pedagogical value in the learning environment. The study findings revealed that the integration of robotic technologies contributes significantly to the development of students' technical, engineering, and creative competencies while simultaneously increasing their engagement and motivation toward learning. Furthermore, the researchers emphasized that robotics serves as an effective instrument for implementing an interdisciplinary approach within STEAM-oriented education [7].

In the study conducted by Dimitra Chaldi et al. (Greece, 2021), educational robotics was explored within an authentic preschool learning environment to promote children's engagement in STEAM education. The researchers employed the programmable robot Bee-Bot as the primary instructional tool. The pedagogical intervention was implemented in two stages. A group of 12 preschool children aged 5–6 years participated in an intensive robotics-based educational program consisting of 16 sessions over a four-week period. During these activities, learners interacted with the bee-shaped robot Bee-Bot® through play-oriented tasks and collaborative exercises. The findings demonstrated that STEAM-oriented learning can be effectively integrated even within speech therapy settings when appropriate educational robotic tools are applied. The young participants improved their foundational programming and computer-related knowledge, developed elements of algorithmic thinking through game-based learning, and simultaneously enhanced their vocabulary acquisition and communication skills [8].

In the research by Ben Haas et al. (Luxembourg, 2022), scholars developed a conceptual framework for distance learning in preschool STEAM education that actively involved parents and integrated modern educational technologies. The initiative was implemented within the context of early childhood education in Luxembourg and aimed to strengthen children's engagement in STEAM-oriented activities through collaborative and technology-supported learning. The outcomes of the project demonstrated significant positive effects on children's educational

development. In particular, learners showed increased motivation toward studying as they actively designed and constructed real-world objects using STEAM-related skills and creative problem-solving approaches. Furthermore, the initiative encouraged stronger parental involvement in children's educational experiences, motivating parents to explore digital learning platforms, participate in experimental activities, and interact more closely with one another throughout the learning process [9].

In a large-scale project developed by Jannik Henze et al. (Germany, 2022), researchers aimed to integrate robotics, coding, and artificial intelligence with the United Nations Sustainable Development Goals within the framework of STEAM education. The project was grounded in the principles of the 5E instructional model, originally introduced in the 1980s and later elaborated by Rodger W. Bybee in his work The BSCS 5E Instructional Model and 21st Century Skills [10]. To expand the traditional structure of the 5E model, the researchers introduced an additional "exchange/sharing" phase as a sixth component of the instructional process. This enhancement was designed to strengthen collaboration, reflection, and communication among participants during STEAM-oriented activities. The findings demonstrated that the integration of the 5E framework with digital creativity tools effectively increased students' engagement in STEAM-related disciplines, including robotics, programming, and artificial intelligence. In addition, the approach contributed to the development of critical thinking, creativity, and problem-solving abilities. The incorporation of the sixth phase focused on reflection and exchange further reinforced metacognitive processes and improved interaction among learners within the educational environment. Overall, the results confirmed the effectiveness of the extended 5E model as an innovative strategy for integrating STEAM education and sustainable development concepts into the modern learning process [11].

Within the framework of the Stimulating European Next Generation through STEAM Education (SENSE) initiative implemented (European Union, 2022 – 2024), researchers developed a European STEAM methodology aimed at integrating science, technology, engineering, arts, and mathematics into the educational process. The project focused on designing innovative teaching strategies and establishing STEAM laboratories intended to enhance learners' practical, experimental, and research-oriented competencies. The implementation outcomes demonstrated that interdisciplinary integration significantly increases young people's interest in STEAM-related fields while also fostering innovative and creative thinking. Furthermore, the project emphasized the importance of the STEAM approach as an effective instrument for developing twenty-first-century competencies within the European educational environment [12].

Conclusion. The conducted analysis of international and European practices demonstrates that STEAM education serves as an effective tool for developing

learners' cognitive, creative, and digital competencies. The integration of interdisciplinary approaches, robotics, project-based learning, and digital technologies contributes to the enhancement of critical thinking, innovation, communication abilities, and collaborative skills. The experience of European Union countries confirms that the most effective educational models are those combining practical activities, inquiry-based tasks, and active interaction among participants in the educational process.

In our opinion, the future development of STEAM education in Ukraine should focus on the further integration of interdisciplinary approaches across all levels of education, including primary school, as well as on the systematic preparation of teachers for working with innovative technologies. Another important direction involves expanding the use of robotics, digital platforms, and project- and research-based learning methods. In the long term, these initiatives may contribute to the formation of a generation of students characterized by advanced innovative thinking and readiness to meet the challenges of a modern technological society.

REFERENCES:

1. United Nations. (2020). The sustainable development goals report 2020. https://unstats.un.org/sdgs/report/2020/;
2. Lu S. Y., Wu C. L., Huang Y. M. (2022). Evaluation of disabled STEAM-students' education learning outcomes and creativity under the UN sustainable development goal: project-based learning-oriented STEAM curriculum with micro: bit. Sustainability 14:679. Doi: 10.3390/su14020679;
3. Shen S., Wang S., Qi Y., Wang Y., Yan X. (2021). Teacher suggestion feedback facilitates creativity of students in STEAM education. Front. Psychol. 12:723171. Doi: 10.3389/fpsyg.2021.72317;
4. Rahmawati Y., Taylor E., Taylor P. C., Ridwan A., Mardiah A. (2022). Students' engagement in education as sustainability: implementing an ethical dilemma-STEAM teaching model in chemistry learning. Sustainability 14:3554. Doi: 10.3390/su14063554;
5. Domenici V. (2022). STEAM project-based learning activities at the science museum as an effective training for future chemistry teachers. Educ. Sci. 12:30. Doi: 10.3390/educsci12010030;
6. Trültzsch-Wijnen, Christine & Velicu, Anca & Liubinienė, Vilmantė. (2022). Robotics for children: National policies and initiatives in three European countries. Medijske studije. 12. 3-20. 10.20901/ms.12.24.1;
7. Kalaitzidou, M., & Pachidis, T. P. (2023). Recent robots in STEAM education. Education Sciences, 13(3), 272. https://doi.org/10.3390/educsci13030272;
8. Chaldi, Dimitra & Mantzanidou, Garyfalia. (2021). Educational robotics and STEAM in early childhood education. Advances in Mobile Learning Educational Research. 1. 72-81. 10.25082/AMLER.2021.02.003;
9. Haas B, Lavicza Z, Houghton T and Kreis Y (2022) Evaluating Technology-Enhanced, STEAM-Based Remote Teaching With Parental Support in

Luxembourgish Early Childhood Education. Front. Educ. 7:872479. Doi: 10.3389/feduc.2022.872479;
10. Bybee, R. W. (2009). The BSCS 5E instructional model and 21st century skills. Paper prepared for the Workshop on Exploring the Intersection of Science Education and the Development of 21st Century Skills;
11. Henze J, Schatz C, Malik S and Bresges A (2022) How Might We Raise Interest in Robotics, Coding, Artificial Intelligence, STEAM and Sustainable Development in University and On-the-Job Teacher Training? Front. Educ. 7:872637. Doi: 10.3389/feduc.2022.872637;
12. European Commission. (2024). SENSE – Stimulating European Next Generation through STEAM Education. https://cordis.europa.eu/project/id/101058507

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ЦИФРОВА ГОТОВНІСТЬ ПЕДАГОГА ДО РОБОТИ В STEAM-ЛАБОРАТОРІЯХ НУШ

Анотація: у статті досліджено феномен цифрової готовності педагога як критичного чинника ефективного функціонування STEAM-лабораторій у контексті реформи НУШ. Автором систематизовано психологічні та технічні бар'єри, що виникають під час адаптації вчителів до роботи з високотехнологічним обладнанням. Особливу увагу приділено концепції педагогічного «скаффолдингу», який забезпечує поступову трансформацію професійної ролі вчителя. Обґрунтовано необхідність переходу від репродуктивного використання цифрових інструментів до моделі інтегрованого менторства. Розкрито роль моделі TPACK як фундаментальної когнітивної бази для розвитку професійної профільної освіти. Запропоновано стратегічні рекомендації щодо модернізації програм підвищення кваліфікації педагогічних кадрів. Результати дослідження підкреслюють, що цифрова готовність є динамічним станом фахової відкритості до інноваційних викликів сучасного освітнього середовища.

Ключові слова: цифрова готовність, STEAM-лабораторія, менторство, технострес, НУШ, модель TPACK, компетентнісний підхід.

Abstract: The article examines the phenomenon of a teacher's digital readiness as a critical factor for the effective functioning of STEAM laboratories within the