

ФОРМУВАННЯ ПРОФЕСІЙНИХ ЯКОСТЕЙ МАЙБУТНІХ ВЧИТЕЛІВ ФІЗИКО-ТЕХНОЛОГІЧНИХ ДИСЦИПЛІН В УМОВАХ STEM-СЕРЕДОВИЩА

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CROSS-CUTTING PRACTICES AS A MEANS OF FORMING METHODOLOGICAL COMPETENCE OF FUTURE TEACHERS OF COMPUTER SCIENCE AND PHYSICS

Abstract. The article considers the role of cross-disciplinary practices as an effective means of forming methodological competence of future teachers of computer science and physics. The essence of the concept of “cross-disciplinary practices” is determined as a continuous integration process that combines theoretical training with students’ practical activities throughout the entire period of professional training. The structure of methodological competence, which includes motivational-value, cognitive, operational-activity and reflective-analytical components, their interrelation and sequence of formation in the process of practice are analyzed. The pedagogical conditions for the effective development of methodological competence are outlined, in particular, the integration of theory and practice, partnership interaction of the university with practice bases, the creation of an innovative educational environment and the active use of digital technologies. The importance of cross-disciplinary practices for training a competitive, creative teacher capable of effectively operating in an inclusive and digital educational space is emphasized.

Key words: cross-curricular practices, methodological competence, future teachers of Computer Science and Physics.

In the process of constant development of higher education, intensification of the process of digitalization, integration of knowledge, increasing requirements for future teachers’ professional training, there is a need to update approaches to applicants’ practical training. One of its key tasks is the formation of future teachers’ methodological competence, which will ensure their readiness for creative, scientifically based and effective professional activity.

The training of future teachers of Computer Science and Physics requires special attention. It is these specialists who influence the formation of students’ scientific outlook, technical culture and skills to use digital tools in the educational process. However, traditional approaches to pedagogical practice often do not provide sufficient integration of theory and practice. An effective way to solve this problem is to introduce cross-disciplinary practices as a systemic mechanism for the formation of methodological competence.

The purpose of the article is to substantiate the theoretical foundations and practical approaches to implementing cross-disciplinary practices into the system of professional training of future teachers of Computer Science and Physics as an effective means of forming their methodological competence.

In the Law of Ukraine “On Higher Education”, pedagogical practice is defined as a logical continuation of the practical application of acquired theoretical knowledge [4]. And cross-curricular practices are a continuous component of the educational process, where higher education

students’ theoretical training and practical activities are integrated throughout their studies.

M.P. Vovk attributes the following to the main challenges and prospects of implementing cross-cutting practices [5]:

- the need to preserve and creatively use the best experience in organizing various types of pedagogical practices with the introduction of innovative ideas;
- the need to reorganize the content and improve the organizational forms of the practical component of the professional training system for future teachers;
- strengthening the relationship between theoretical, research and practical training of students;
- active implementation of interdisciplinary interaction, combining theoretical knowledge with the latest forms, methods and technologies of teaching in practical activities;
- search for effective models of internships in conditions of martial law and changes in the educational environment;
- expanding the use of dual education as a means of integrating the educational process with real pedagogical practice.

The modern system of future teachers’ practical training is in the process of constant renewal, which is due to the reform of education, the digitalization of the educational environment and the need for highly qualified spe-

cialists capable of creative and research activities. In this context, the leading trends in the development of future teachers' practical training are identified, which determine the content and directions of modernization of the educational process [5]:

- preservation and development of the best traditions of organizing various types of pedagogical practices developed in higher education institutions;
- innovative approaches to using interactive forms, methods and technologies of learning in order to form students' professional competencies during their internship;
- establishing partnerships between educational institutions, cultural and educational institutions, laboratories, libraries, museums and other educational centers;
- pragmatic orientation of the organization of internships, focused on collecting and systematizing empirical data for performing qualification work and gaining practical experience for future professional activities;
- active use of remote forms of organizing practice, which has become particularly important in the context of the pandemic and martial law in Ukraine, can be ensured by using platforms such as Google Classroom, Moodle, Microsoft Teams, Zoom, etc.;
- the need to strengthen financial support for teaching practices, ensuring their modern logistical support.

Thus, these trends reflect the desire of the educational community to combine traditions and innovation, which contributes to the creation of a holistic, dynamic system of teachers' practical training, focused on the formation of their professional and methodological competence.

Modern scientists A.A. Sbrueva, O.B. Kryvonos, N.V. Kovalenko, N.G. Osmuk, D.V. Budyansky, M.M. Bykova, I.I. Protsenko, M.A. Boychenko, Zh.Yu. Chernyakova, M.A. Boychenko, I.A. Chistyakova point to a teacher's new modern role, which is formed under the influence of a complex of interrelated factors caused by a deep transformation in the educational and social spheres. Such implementation does not occur spontaneously, but requires systemic changes in pedagogical personnel's training and ensuring their continuous professional growth. These changes cover the following key areas of reform [9]:

- orientation of the educational process towards achieving new learning outcomes;
- modernization and restructuring of the content and forms of organization of educational activities;
- development of extracurricular and after-school work in the context of cooperation with various social institutions;
- integration of information and communication technologies into all aspects of pedagogical practice;
- increasing the level of a teacher's professionalism and forming personal responsibility for one's own professional improvement.

According to P.S. Atamanchuk, conducting various types of internships allows applicants to familiarize themselves with the real system of educational work in secondary education institutions, to gain experience in planning, conducting lessons by teachers, conducting a class teacher's extracurricular work, organizational and educational work. In particular, during internships, students have the opportunity to perform a large amount of independent work, to show pedagogical creativity at all stages of peda-

gogical work, to acquire skills in communicating with students, teachers and parents [2].

During the course of end-to-end practices, a special place is occupied by the formation of methodological competence of future teachers of Computer Science and Physics [7].

End-to-end practices are an integral and continuous component of the educational process, ensuring the integration of higher education students' theoretical training and practical activities throughout the entire period of their professional development.

In pedagogical training, end-to-end practices are considered as a continuous, integrated process of practical learning, which covers all stages of obtaining higher education. Its main task is to create conditions for the gradual formation of professional experience in students, which is based on a deep understanding of pedagogical patterns, teaching methods and psychological aspects of a teacher activity [1].

End-to-end practices are systemic, long-term and holistic in nature, unlike traditional short-term practices. This ensures the unity of theoretical training and practical application of knowledge with the integration of various types of activities (educational, methodological, research, educational), orients the higher education student towards continuous professional self-improvement [6].

End-to-end practices occupy a special place in the structure of future specialists' professional training, as they ensure the continuity and integrity of the process of gaining practical experience, contribute to the integration of theoretical knowledge and real pedagogical activity. Through the completion of end-to-end practices, favorable conditions are created for a gradual transition from observing the educational process to independent performance of professional functions, the formation of the ability to reflexively evaluate one's own activities and improve pedagogical activity [10].

Modern cross-curricular practices involve the active use of digital and interactive technologies that meet the specifics of the professional activities of a teacher of Computer Science and Physics. Effective tools include: virtual laboratories (PhET, Algodoo, Multisim, Tinkercad), learning management systems (Moodle, Google Classroom, Microsoft Teams), elements of STEM/STEAM education, a student's digital portfolio, pedagogical mentoring and coaching, and more.

In the context of training future teachers of Computer Science and Physics, cross-curricular practices provide a systematic combination of theoretical and methodological knowledge with the practical application of modern digital technologies, experimental methods and pedagogical innovations. This approach has a positive impact on the formation of a future teacher's methodological competence – the ability to design, organize and analyze the educational process using information and communication tools, model educational situations, select optimal methods and techniques of teaching in accordance with students' educational needs.

The organization of cross-disciplinary practices at the Educational-and-Scientific Institute of Information and Educational Technologies of Bohdan Khmelnytskyi National University of Cherkasy in the process of training future teachers of Computer Science and Physics is cross-disciplinary in nature and provides for the following types of practices: educational practice (3-5 semesters), production pedagogical practice (6, 7 semesters), research

practice (8 semester) [10]. This approach allows ensuring continuity and increasing complexity of tasks, forming in applicants not only professional skills, but also pedagogical thinking, reflection, and creativity.

The results of the end-to-end practices have shown that such methodological training of future teachers of Computer Science and Physics contributes to the formation and development of pedagogical erudition, professional thinking and intuition; ensures the effective formation of the skills of a creative approach and pedagogical improvisation; stimulates the acquisition of professional optimism and the ability to reflectively analyze one's own activities [10].

Passing through-the-course practices is not only a stage of professional development, but also an effective mechanism for forming methodological competence, which allows future teachers of Computer Science and Physics to consciously combine knowledge, skills, and pedagogical creativity into a single professional system.

Cross-curricular practices act as an integration environment within which all components of methodological competence interact in a single educational process, ensuring the holistic professional development of future teachers of Computer Science and Physics.

Scientists interpret a teacher's methodological competence as the ability to master a system of knowledge, skills and abilities that develops taking into account a teacher's individual personal characteristics, forming a teacher's readiness to effectively organize educational activities and demonstrate their creative potential in pedagogical activity [11].

N.V. Shataylo believes that methodological competence is "a complex integrated formation of a personality, which includes a complex of abilities and readiness for methodological activity, general pedagogical and special knowledge, skills and abilities, pedagogical values, a teacher's methodological experience and personal qualities, which in their interconnection and interaction ensure the effective implementation of the educational process. The content of methodological competence is expediently revealed through structural components: cognitive, value-and-motivational, activity-and-technological, which determine the existence of methodological knowledge, skills, personal traits, pedagogical values and experience in a teacher that are subject to transformation in the process of professional development" [13].

The structure of methodological competence of future teachers of Computer Science and Physics in the context of cross-curricular practices is presented in *Figure 1*.

Its structure includes a set of interrelated components that ensure readiness for the effective implementation of the educational process:

– *motivational-and-value component*, which manifests itself in a sustained interest in pedagogical activity, awareness of its social significance, and the desire for self-development;

– *cognitive component* reflects the level of mastery of theoretical and methodological knowledge in professional disciplines, understanding of didactic principles, regularities of teaching Physics and Computer Science, and mastery of modern pedagogical technologies;

– *operational component* assumes the formation of skills and abilities in organizing the educational process (designing lessons, selecting teaching methods and tools, using digital technologies and experimental equipment, conducting educational research).

– *reflective-and-analytical component* provides the ability to self-assess pedagogical activities, analyze the results of one's own work, and create an individual teaching style.

Through the completion of end-to-end practices, all components of methodological competence are consistently formed: from initial familiarization with the educational environment to full immersion in professional activity. This contributes to a future teacher's holistic development, his/her readiness for the creative application of acquired knowledge and skills in real school conditions.

For the effective formation of methodological competence of future teachers of Computer Science and Physics is largely determined by the creation of appropriate pedagogical conditions. This ensures the integrity, continuity and effectiveness of end-to-end practices. An important stage in the formation of methodological competence is the integration of theoretical and practical training, which assumes the consistency of the content of professional, psychological, pedagogical and methodological disciplines with the tasks of students' practical activities. Such integration provides an opportunity to ensure a gradual transition from the acquisition of knowledge to its practical application in a real educational environment.

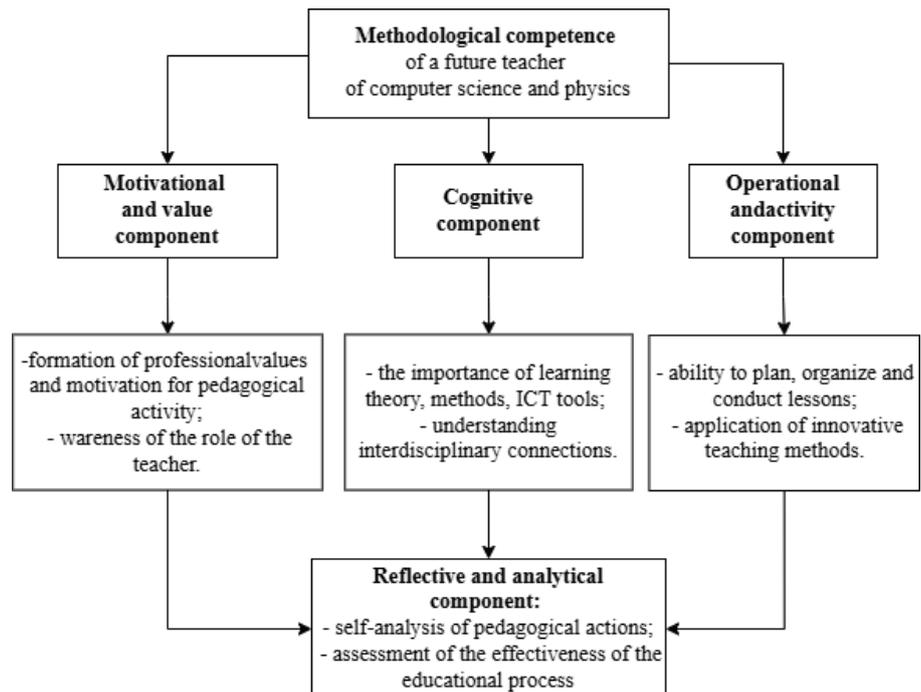


Fig. 1. Structure of methodological competence of future teachers of Computer Science and Physics in the context of cross-curricular practices

The next condition for the formation of methodological competence of future teachers of Computer Science and Physics is the creation of an educational and methodological environment focused on a student's professional growth: the development of end-to-end programs of practices, cases and situational tasks, the use of digital technologies, cloud services and virtual laboratories for modeling pedagogical situations. Such an environment has a positive impact on the formation of a future teacher's readiness to work in a digital school and contributes to the development of creativity, pedagogical reflection, analytical thinking.

In particular, an important pedagogical condition is the partnership between the university and the internship bases, which is implemented through joint planning, mentoring, consulting and support of students. During such cooperation, the realism of the educational experience is ensured, which contributes to the formation of professional communication skills, responsibility, and pedagogical ethics.

In addition, it is essential to organize students' reflective and analytical activities aimed at understanding their own achievements and difficulties, outlining individual strategies for professional improvement. It can be implemented through maintaining an electronic portfolio, practice diaries, and participating in collective discussions of the results of pedagogical experience.

The creation of these pedagogical conditions in the process of completing end-to-end practices ensures not only the effective formation of methodological competence of future teachers of Computer Science and Physics, but also the formation of their readiness for innovative, research and creative pedagogical activity.

Methodological competence is defined as a person's integrative quality, encompassing a system of knowledge, skills, values, and experience necessary for effective planning, organization, implementation, and analysis of the educational process. For future teachers of Computer Science and Physics, it implies mastery of teaching methods for the natural and mathematical cycle; the ability to select and apply innovative teaching aids, including digital technologies; the ability to conduct pedagogical reflection and self-assessment of the results of one's own activities; and the readiness to implement interdisciplinary approaches in teaching.

End-to-end practices provide conditions for the formation of all these components, as they involve a student's real inclusion in professional activities, from observing lessons to independently conducting training sessions using modern educational technologies.

Particular attention should be paid to future teachers' methodological competence in inclusive education, which is a key component of professional readiness for effective pedagogical activity. In the process of completing cross-curricular practices, this competence is formed on the basis of the integration of theoretical knowledge, practical experience, pedagogical reflection and awareness of the values of inclusive education [3].

The completion of cross-curricular practices creates a favorable environment for developing future teachers' ability to adapt teaching methods to students' different educational needs, develop individual educational trajectories, use differentiated approaches to learning, and also establish interaction between all participants in the educational process – students, parents, teacher assistants, and specialists in psychological and pedagogical support [3].

The formation of methodological competence during the completion of cross-disciplinary practices by future teachers of Computer Science and Physics in an inclusive educational space covers the following aspects (Fig. 2): cognitive, practical, communicative and reflective components.

Cross-curricular practices become an important platform for developing methodological competence in future teachers of Computer Science and Physics that meets the requirements of inclusive education. It contributes to the formation of a humanist teacher who possesses not only professional knowledge, but also a high level of pedagogical culture, flexibility of thinking, and readiness to work in a diverse educational environment.

The results of the study show that cross-cutting practices as a means of forming methodological competence of future teachers of Computer Science and Physics is not only a stage of professional development, but also an effective mechanism for the development of methodological competence, which integrates knowledge, skills and pedagogical creativity into a single professional system. This method of implementing practice has a positive impact on the high-quality training of a competitive, flexible, innovation-oriented specialist capable of working in digital and inclusive education.

Further research should be directed towards the development of digital pedagogical models for implementing cross-cutting practices and criteria for assessing the level of methodological competence of future teachers of Computer Science and Physics.

References:

1. Current problems of education quality management: theory, history, innovative technologies: monograph / edited by A.A. Sbrueva. Sumy: Publishing house of Sumy State University of Education named after A.S. Makarenko, 2017. 340 p.

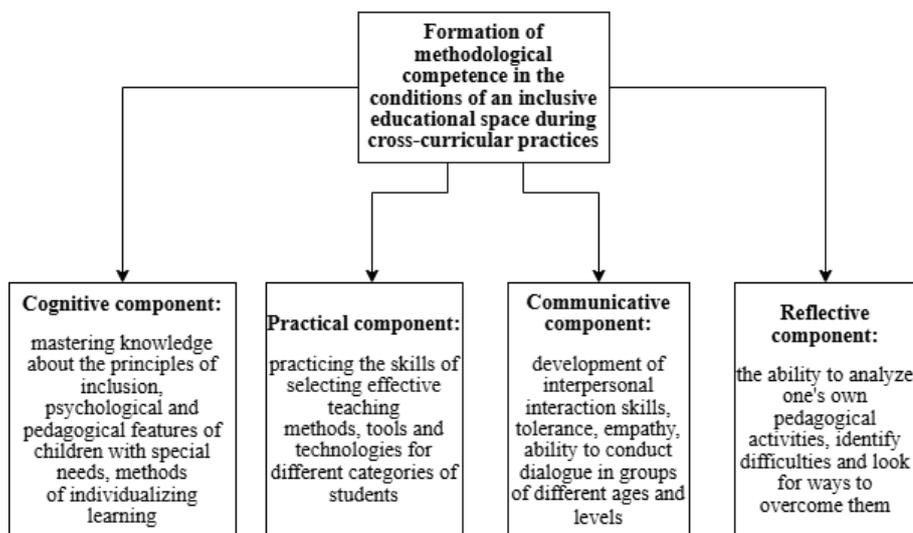


Fig. 2. Formation of methodological competence during cross-disciplinary practices by future teachers of Computer Science and Physics in an inclusive educational space

- Atamanchuk P.S., Poveda T.P. Pedagogical practice – an indicator of the readiness of a future physics teacher for professional activity. *Scientific journal "Physical and mathematical education"*. Sumy, 2017. Issue 2 (12). P. 17-20.
- Bakhmat N. Methodological competence of a teacher in inclusive education. *New Inception*. 2022. 1-2 (7-8). P. 52–61. URL: <https://doi.org/10.5281/zenodo.7101894>
- Verkhovna Rada of Ukraine. Law of Ukraine "On Higher Education". URL: <https://zakon.rada.gov.ua/laws/show/1556-18>
- Vovk M.P. Experience of organizing various types of practice in teacher training: Ukrainian and foreign context / Continuing pedagogical education of the 21st century. *Collection of materials of the 19th International Pedagogical and Artistic Readings in Memory of Prof. O.P. Rudnytska* / [scientific ed.: G.I. Sotska, M.P. Vovk]. Kyiv: Talkom, 2022. Issue 5 (17). P. 36-38.
- Methodological recommendations for the organization, conduct and completion of pedagogical practice for applicants for higher education of the second (master's) level in the educational and professional program "Informatics and information technologies in education" specialty 014.09 – Secondary education (Informatics): method. recommendations / compiled by V.A. Litovchenko. Chernivtsi: Chernivtsi national University named after Yu. Fedkovycha, 2024. 54 p. URL: <https://surl.lt/avdwvr>
- Cross-cutting pedagogical practice: teaching-methodical manual. 3rd edition, supplemented and revised / Sumy State Pedagogical University named after A.S. Makarenko; scientific editor A.A. Sbrueva. Sumy: Publishing house of Sumy State Pedagogical University named after A.S. Makarenko, 2019. 335 p.
- Romanenko T.V., Tkachenko A.V. Modern approaches to the content of professional practices of future teachers of physics and computer science. *Scientific research work in the system of training specialists-teachers in natural, technological and computer fields: materials of the X All-Ukrainian Scientific and Practical Internet Conference* (September 26, 2025). Zaporizhzhia: BDPU, 2025. P. 145-148.
- Tsybalyuk Ya.S. Structure of teacher's methodological competence. URL: https://scienceandeducation.pdpu.edu.ua/doc/2011/4_2011/58.pdf
- Shataylo N.V. Methodological competence of a teacher: theoretical aspect. *Innovative pedagogy. Theory and methodology of professional education*. 2024. Issue 68. Volume 2. P. 182-185. URL: http://www.innovpedagogy.od.ua/archives/2024/68/part_2/39.pdf

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НАСКРІЗНІ ПРАКТИКИ ЯК ЗАСІБ ФОРМУВАННЯ МЕТОДИЧНОЇ КОМПЕТЕНТНОСТІ МАЙБУТНІХ ВЧИТЕЛІВ ІНФОРМАТИКИ ТА ФІЗИКИ

Анотація. У статті розглянуто роль наскрізних практик як ефективного засобу формування методичної компетентності майбутніх учителів інформатики та фізики. Визначено сутність поняття «наскрізні практики» як безперервного інтеграційного процесу, що поєднує теоретичне навчання з практичною діяльністю студентів протягом усього періоду професійної підготовки. Проаналізовано структуру методичної компетентності, яка включає мотиваційно-ціннісний, когнітивний, операційно-діяльнісний та рефлексивно-аналітичний компоненти, їх взаємозв'язок і послідовність формування у процесі практики. Окреслено педагогічні умови ефективного розвитку методичної компетентності, зокрема інтеграцію теорії та практики, партнерську взаємодію університету з базами практики, створення інноваційного освітнього середовища й активне використання цифрових технологій. Наголошено на значенні наскрізних практик для підготовки конкурентоспроможного, творчого педагога, здатного ефективно діяти в умовах інклюзивного та цифрового освітнього простору.

Ключові слова: наскрізні практики, методична компетентність, майбутні вчителі інформатики та фізики.

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ФОРМУВАННЯ ЕЛЕМЕНТІВ ОПЕРАЦІЙНО-МЕТОДИЧНОЇ КОМПЕТЕНТНОСТІ МАЙБУТНІХ УЧИТЕЛІВ ФІЗИКИ У ХОДІ ЇХ ФАХОВОЇ ПІДГОТОВКИ

Анотація. У статті розглянуто проблему формування елементів операційно-методичної компетентності майбутніх учителів фізики у ході їх фахової підготовки в контексті впровадження в освітній процес з фізики сучасної наукової інформації. Констатовано, що, незважаючи на важливість педагогічної проблеми впровадження елементів сучасних наукових знань в навчання фізики у закладах середньої освіти, увага до неї є незначною. Виокремлено результати навчання фізики, яких можна досягти шляхом ознайомлення учнів із сучасною науково-технічною інформацією. Розглянуто методичні підходи до впровадження наукової інформації в навчання фізики, з якими необхідно знайомити майбутніх учителів у ході їх фахової підготовки. Обґрунтовано, що у разі системного і комплексного підходу до ознайомлення учнів з досягненнями фізики, в них буде підвищуватись інтерес до її вивчення, до розуміння фізичних законів і теорій, адже на них засновані сучасні технології. Доведено, що за цих умов учень сприйматиме теоретичний, експериментальний та технологічний компоненти наукової картини світу у нерозривній єдності. Наголошено, що для реалізації цього важливого завдання учитель фізики повинен мати відповідний рівень операційно-методичної компетентності, який може бути ефективно сформований у ході його фахової підготовки при вивченні дисциплін професійного циклу.

Ключові слова: освітній процес з фізики, сучасна наукова інформація, операційно-методична компетентність майбутніх учителів фізики.