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Ivan HAINIUK,

a student at the third (educational and research) cycle of higher education
in the specialty 015 Professional Education (by specialization),
Vasyl Stefanyk Carpathian National University (Ivano-Frankivsk, Ukraine)

Іван ГАЙНЮК,

здобувач третього (освітньо-наукового) рівня вищої освіти
зі спеціальності 015 Професійна освіта (за спеціалізаціями),
Карпатський національний університет імені Василя Стефаника (м. Івано-Франківськ, Україна)
ivan.hainiuk.22@pnu.edu.ua
ORCID ID 0009-0005-2923-8586

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CONTENT AND STRUCTURAL COMPONENTS OF THE PROFESSIONAL TRAINING OF FUTURE SCIENCE TEACHERS FOR THE APPLICATION OF STEM TECHNOLOGIES

Abstract. The article explores the content and structural components of the professional training of future science teachers for the application of STEM technologies in the educational process. The relevance of the study is determined by the growing importance of interdisciplinary integration, the development of inquiry-based and project-based learning, the digitalization of education, and the need to modernize science teacher education. The significance of integrating STEM approaches into the teaching of professional disciplines, organizing experimental and research activities, implementing interdisciplinary projects, and using digital educational resources is substantiated. The expediency of combining theoretical, practical, and methodological training with pedagogical modeling, microteaching, and professionally oriented tasks is established. Five interrelated structural components of professional training are identified: motivational-value, cognitive, operational-activity, design-methodological, and reflective-evaluative. Their significance in fostering positive motivation towards STEM education, acquiring interdisciplinary knowledge, developing practical skills, designing integrated learning, and improving professional activities is revealed. It is emphasized that the interaction of these components ensures the integrity of professional training and promotes the development of research culture, creative thinking, and professional autonomy among future teachers. The practical significance of the study lies in the possibility of using its findings to improve the content of subject-specific and methodological educational components, develop STEM-oriented tasks, and organize project-based activities for higher education students. Further research prospects involve developing and experimentally validating a model of professional training, identifying the pedagogical conditions for its implementation, and establishing criteria for assessing the development of the corresponding readiness.

Keywords: professional training, future science teachers, STEM technologies, STEM education, interdisciplinary integration, research activities, project-based learning, motivational-value component, cognitive component, operational-activity component, design-methodological component, reflective-evaluative component.

ЗМІСТ ТА СТРУКТУРНІ КОМПОНЕНТИ ПРОФЕСІЙНОЇ ПІДГОТОВКИ МАЙБУТНІХ УЧИТЕЛІВ ПРИРОДНИЧИХ ДИСЦИПЛІН ДО ЗАСТОСУВАННЯ STEM-ТЕХНОЛОГІЙ

Анотація. У статті розкрито зміст і структурні компоненти професійної підготовки майбутніх учителів природничих дисциплін до застосування STEM-технологій в освітньому процесі. Актуальність дослідження зумовлена посиленням міждисциплінарної інтеграції, розвитком дослідницького та проєктного навчання, цифровізацією освіти й необхідністю модернізації природничої підготовки педагогів. Обґрунтовано значення інтеграції STEM-підходів у викладання фахових дисциплін, організації експериментальної та навчально-дослідницької діяльності, виконання міждисциплінарних проєктів і використання цифрових освітніх ресурсів. Визначено доцільність поєднання теоретичної, практичної та методичної підготовки з педагогічним моделюванням, проведенням мікроуроків і виконанням професійно орієнтованих завдань. Виокремлено п'ять взаємопов'язаних структурних компонентів професійної підготовки: мотиваційно-ціннісний, когнітивний, операційно-діяльнісний, проєктувально-методичний і рефлексивно-оцінювальний. Розкрито

їхнє значення для формування позитивної мотивації до STEM-освіти, засвоєння міждисциплінарних знань, розвитку практичних умінь, проєктування інтегрованого навчання та вдосконалення професійної діяльності. Наголошено, що взаємодія визначених компонентів забезпечує цілісність підготовки, розвиток дослідницької культури, творчого мислення та професійної самостійності майбутніх педагогів. Практичне значення дослідження полягає в можливості використання його результатів для вдосконалення змісту фахових і методичних освітніх компонентів, розроблення STEM-орієнтованих завдань та організації проєктної діяльності здобувачів вищої освіти. Перспективи подальших досліджень пов'язані з розробленням та експериментальною перевіркою моделі професійної підготовки, визначенням педагогічних умов її реалізації й критеріїв оцінювання сформованості відповідної готовності.

Ключові слова: професійна підготовка, майбутні вчителі природничих дисциплін, STEM-технології, STEM-освіта, міждисциплінарна інтеграція, дослідницька діяльність, проєктне навчання, мотиваційно-ціннісний компонент, когнітивний компонент, операційно-діяльнісний компонент, проєктувально-методичний компонент, рефлексивно-оцінювальний компонент.

INTRODUCTION

The problem formulation. The modern transformation of science education highlights the need to rethink the content of the professional training of future teachers of biology, chemistry, physics, geography, and integrated courses within the natural science educational field. This is associated with the transition from a predominantly subject-knowledge-based model of learning to an integrated, competency-based, activity-oriented, and research-oriented educational paradigm. STEM technologies are becoming particularly important in this process, as their application involves the integration of natural sciences, technology, engineering, and mathematics to solve practice-oriented and research tasks.

In the context of updating the content of science education, improving the professional training of future teachers of biology, chemistry, physics, geography, and integrated courses within the natural science educational field is becoming particularly relevant. This need is driven by changing educational priorities: instead of the traditional acquisition of a system of subject-specific knowledge, increasing importance is being attached to interdisciplinary integration, the competency-based approach, practical activities, and the involvement of students in research inquiry.

An important means of implementing these priorities is the use of STEM technologies, which ensure the integration of natural science knowledge with technological, engineering, and mathematical tools for analyzing real-world problems, conducting experiments, and developing practically significant solutions.

Despite the existence of theoretical studies and practical developments concerning the implementation of STEM technologies in the educational process, their application in the professional activities of science teachers requires a systematic and methodologically substantiated approach.

The effectiveness of STEM education depends not only on the availability of digital resources, laboratory equipment, or innovative teaching tools, but also on teachers' readiness to integrate natural science knowledge with mathematics, technology, and engineering; organize students' research activities; develop interdisciplinary projects; and create conditions for fostering critical thinking, creativity, and the ability to solve practice-oriented tasks. As V. Onipko emphasizes in her research, «The professional training of future teachers in the natural science educational field should focus on developing an integrated set of general and professional competencies defined in the Strategy for the Development of Higher Education in Ukraine for 2022–2032 (critical thinking, research, digital, environmental, communication, and innovation competencies), the outcome of which is a graduate's readiness to organize experimental research, integrated learning, and STEM-oriented instruction in the context of the New Ukrainian School» (Onipko, 2025).

Under these circumstances, the professional training of future science teachers for the application of STEM technologies is becoming particularly relevant. It is important to consider that proficiency in individual digital tools or knowledge of the theoretical foundations of STEM education does not, in itself, guarantee a future teacher's ability to independently design and implement STEM-oriented learning. This requires the integration of fundamental natural science training, psychological and pedagogical knowledge, methodological competence, practical skills in organizing research and project activities, as well as readiness for reflection and continuous improvement of one's own professional practice.

Analysis of recent research and publications. An important direction in the renewal of higher pedagogical education is the development of a professionally competent generation of teachers capable of generating innovative ideas, finding unconventional ways to address pedagogical problems, and creatively applying modern educational technologies in their professional activities. The scientific and theoretical foundations of the professional development and training of future teachers in higher education institutions have been addressed in the works of numerous Ukrainian and international researchers, including N. Bibik, V. Bondar, N. Huzii, N. Kichuk, L. Kondrashova, Z. Kurland, L. Martynets, V. Radul, and other scholars.

An important place in the scientific discourse is occupied by studies devoted to substantiating the theoretical and methodological foundations of vocational education, as represented in the scholarly contributions of I. Bekh, M. Yevtukh, S. Nikolaienko, V. Prykhodko, A. Silveistr, S. Sysoieva, L. Khoruzha, and other researchers.

The essence of the problem associated with highlighting the specific features of training this category of teachers within the educational process of modern educational institutions is examined in the scholarly works of Ukrainian researchers O. Barna, I. Chervinska, N. Valko, O. Hirnyi, N. Polikhun, and others.

N. Polikhun, I. Slipukhina, and I. Chernetskyi investigated the foundations of the emergence and development of STEM as an educational strategy, its relevance, and the didactic features of its implementation in the Ukrainian education system. The scholars analyzed the main trends and processes involved in introducing the STEM approach into national educational practice, particularly in the context of gifted education, and outlined the prospects for its application as a tool for reforming the national education system (Polikhun, & Slipukhina, Chernetskyi, 2017).

Researcher O. Hirnyi focused on examining the interrelationships between STEM education and other educational fields. To this end, the author conducted a comparative analysis of the lists of academic subjects and educational fields represented in various STEM models implemented in the United States and European countries, comparing them with STEM subjects included in the curricula of Ukrainian educational institutions and the leading STEM fields recommended by the U.S. National Science Foundation (Hirnyi, 2019). A group of researchers comprising N. Stetsula, N. Novykova, U. Malaniak, and N. Lisnianska are studying the specific features of applying the fundamental principles of STEM education in geography lessons.

O. Barna substantiated specific organizational and methodological measures for implementing STEM education in educational institutions. Among the main areas, the researcher identifies the selection of an optimal model for implementing STEM education in accordance with the specific nature of an educational institution's activities and its chosen areas of specialization, as well as the development and implementation of didactic and digital tools to support it. The author places particular emphasis on creating a team of motivated professional teachers committed to innovation and change, whose activities are «aimed at achieving defined goals and expected learning outcomes» (Barna, 2019). The author considers the particular value of STEM education to lie in the integration of natural sciences, mathematics, technology, and engineering into a coherent learning system that ensures the interdisciplinary nature of the educational process and its practical orientation.

Researcher N. Valko, in the article «Theoretical and Methodological Foundations of Training Future Teachers of Natural Sciences and Mathematics for the Application of STEM Technologies», examined the specific features of the «professional training of future teachers for the use of STEM technologies and the development of their readiness to introduce the STEM approach into the practice of general secondary education institutions. The researcher identified the main stages of the professional and practice-oriented training of future teachers and developed organizational and methodological guidelines for implementing this process, aimed at ensuring the effective application of STEM technologies in their future professional activities» (Valko, 2018; 2020). The above demonstrates the relevance of seeking innovative approaches to developing their professional competence, creative potential, and readiness to implement modern educational technologies.

THE AIM AND RESEARCH TASKS

The purpose of the article. The purpose of the study is to reveal the content and describe the structural components of the professional training of future science teachers for the application of STEM technologies.

Research objectives: to analyze the specific features of applying STEM technologies, taking into account the integration of natural sciences, technology, engineering, and mathematics, project-based activities, and inquiry-based learning; to identify and substantiate the structural components of the professional training of future science teachers for the application of STEM technologies, and to reveal their functions and interrelationships.

RESEARCH METHODS

The methodological basis of the study comprises a set of complementary theoretical and empirical methods, the selection of which is determined by the research purpose and the defined objectives. The theoretical methods include analysis and synthesis, comparison, systematization, and generalization of scientific and pedagogical sources, regulatory and legal documents, and the content of educational and professional programmes. Their application is aimed at clarifying the theoretical foundations of the research problem, identifying the main approaches to the professional training of future teachers, and determining the possibilities for integrating STEM technologies into this process. The structural-systemic method is used to identify the structural components of professional training, establish the relationships between them, and develop a holistic understanding of future teachers' readiness to use STEM technologies.

RESULTS OF THE RESEARCH

In the context of the technologization and digitalization of education, the content and structural organization of the training of future educators for the application of STEM technologies are becoming particularly important. This process involves the integration of natural science knowledge, engineering thinking, digital tools, and project-based research activities. At the same time, the potential of STEM technologies for developing future teachers' creative initiative, their ability to develop original methodological solutions, and their capacity to design an innovative educational environment requires further theoretical substantiation and methodological support.

In this context, the statement made by scholars O. Akimova and V. Haluziak in their monograph Pedagogical Support for the Personal and Professional Development of Future Teachers is particularly relevant. The authors «emphasize that the system of professional training, as a social value, encompasses a set of knowledge, skills, abilities, and attitudes that determine future teachers' capacity for activity-based research, the integration of digital and STEM technologies into science teaching, and the implementation of sustainable development principles. In the context of modern higher education, the development of such competencies is becoming an integral component of training a competitive specialist capable of making independent decisions in the scientific and environmental domain and adhering to innovative and ethical standards» (Akimova & Haluziak, 2019).

We agree with the positions outlined above and believe that efforts to improve the level of professional training of future science teachers should be analyzed not only in terms of the process of acquiring subject-specific knowledge and methodological skills, but also as a comprehensive system for developing readiness to use technologies creatively in future teaching practice. Its content should encompass the acquisition of interdisciplinary approaches, project-based and problem-based learning technologies, methods for organizing experimental and research activities, digital modeling tools, and instruments for assessing learning outcomes.

The challenges outlined above concerning «the professional training of future teachers in the natural science educational field determine the need to introduce modern educational technologies and teaching methods into the educational process of higher education institutions, adapted to the requirements of the contemporary educational environment. In particular, teachers should possess not only theoretical knowledge but also skills in using experimental research methods, interactive technologies, virtual laboratories, and so forth» (Zasekina & Truskavetska, 2024, p. 76).

The structural components of such training should ensure the interrelationship of all elements aimed at developing motivation for teaching, creating a body of STEM-oriented knowledge, acquiring practical skills for designing and implementing integrated learning tasks, as well as developing the ability to analyze and improve one's own professional experience. Thus, the application of STEM technologies is not merely a means of modernizing science education but also an indicator of readiness to independently design an innovative educational process. A schematic representation of this multifaceted process is presented in Fig. 1.

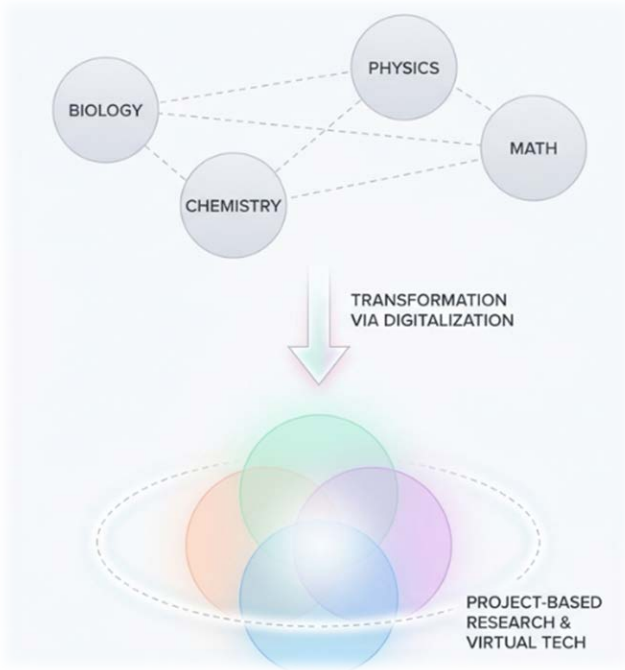


Fig. 1. Professional Training of Future Science Teachers for the Application of STEM Technologies

This complex process should be viewed as a holistic, consistent, and multi-component process involving the implementation of interrelated areas. The first area encompasses the integration of STEM technologies into the teaching of subject-specific disciplines, the completion of laboratory and practical assignments, the conduct of educational research, and the implementation of interdisciplinary projects.

This will enable future teachers not only to deepen their natural science knowledge but also to gain first-hand experience in using STEM tools as learners, understand their didactic potential, and identify the conditions for their effective application in future teaching practice.

The second area involves the purposeful development of teachers' methodological readiness. Methodology courses should provide for the acquisition of algorithms for designing STEM tasks, methods for organizing students' research and project activities, approaches to integrating the content of biology, geography, physics, chemistry, and mathematics, as well as methods for assessing learning outcomes. A fundamental component of such training is the modeling of pedagogical situations, the development of STEM projects, the delivery of micro-lessons, and teaching practice, during which students learn to adapt technologies to learners' age-related characteristics, educational objectives, and the resources available at an educational institution (Fig.2).

The above-mentioned areas of professional training necessitate the identification of its structural components. Within the scope of the research problem and taking into account the findings presented in the dissertation studies by K. Yurchenko and O. Lozova (Yurchenko, 2024; Lozova, 2025), we have identified the following components: motivational-value, cognitive, operational-activity, design-methodological, and reflective-evaluative. The content of

each component is aimed at providing a comprehensive understanding of the process of preparing future science teachers for the application of STEM technologies.

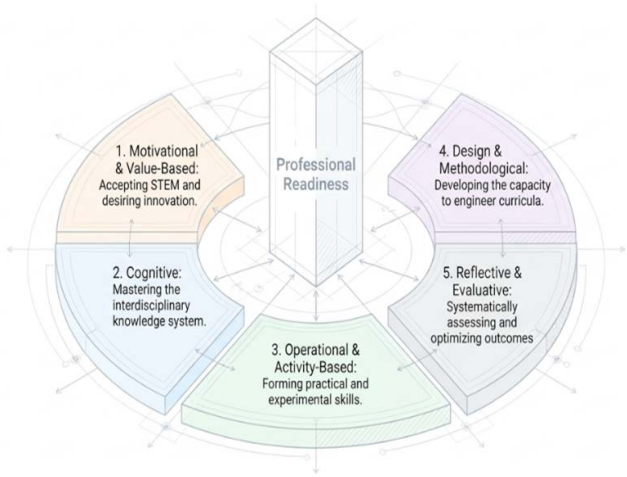


Fig. 2. Content of the Components of the Training of Future Science Teachers

Within the context of our study of the identified problem, we propose considering five interrelated components that reflect the main areas of this activity: motivational acceptance of STEM education, acquisition of the necessary knowledge, development of practical skills, enhancement of the ability to undertake methodological design, and reflective understanding of the outcomes of professional activities. Let us examine these components in greater detail.

The motivational-value component reflects the development of future teachers' professional motivation to implement STEM technologies, their awareness of the importance of these technologies for improving the quality of science education, and their readiness for continuous professional self-improvement.

The motivational-value component is an important element of the professional training of future teachers for the implementation of STEM education. It characterizes a future teacher's internal readiness to introduce STEM approaches into the educational process, their aspiration to use modern teaching methods, organize students' research and project activities, and develop their own professional competencies.

An important aspect of this component is future teachers' awareness of the educational potential of the STEM approach, which involves the integration of natural sciences, technology, engineering, and mathematics, as well as an orientation towards the practical application of knowledge. Particularly relevant in this regard is the statement that «Positive motivation towards STEM activities is a necessary condition for the effective implementation of interdisciplinary learning» (Yurchenko, 2024). Thus, the motivational-value component encompasses future teachers' interest in STEM education, their awareness of its pedagogical appropriateness, readiness for creative inquiry, responsibility for students' learning outcomes, and aspiration for continuous professional development. The effectiveness of this component is manifested in students' active participation in STEM projects, their interest in innovative educational technologies, readiness to collaborate with colleagues, and openness to experimentation. Its development is ensured by engaging future teachers in practice-oriented tasks, research activities, professional discussions, educational projects, and reflective analysis of the outcomes of their own activities.

The cognitive component encompasses a system of knowledge about the conceptual foundations of STEM education, interdisciplinary integration, the patterns governing natural phenomena, modern teaching technologies, digital tools, methods of scientific inquiry, and principles for organizing students' research activities. It characterizes the system of professional knowledge that future teachers need to understand the theoretical foundations of STEM education, identify its didactic potential, and organize integrated learning in a methodologically sound manner. Its content includes knowledge of the conceptual principles of the STEM approach, interdisciplinary connections between natural sciences, mathematics, technology, and engineering, methods of inquiry-based learning, the design of educational situations, and the use of modern teaching tools.

Scientific studies emphasize that «The cognitive component of readiness involves the development of a system of knowledge about the essence of STEM education, interdisciplinary connections, and methods of organizing research activities» (Yurchenko, 2024). This provides grounds for considering the cognitive component not merely as a body of acquired theoretical information, but also as a foundation for making informed choices regarding the content, methods, and technologies of teaching in accordance with established educational objectives. The integrated nature of professional knowledge is of particular importance. A teacher needs to know how to establish meaningful connections between academic disciplines, explain natural phenomena on the basis of the principles of different sciences, identify opportunities for the practical application of theoretical concepts, and select learning materials for solving complex tasks. Such an approach contributes to the development of a holistic scientific worldview.

An important element of this component is familiarity with modern STEM technologies, digital educational resources, modeling tools, virtual laboratories, and data visualization instruments. Future teachers should understand the didactic potential of these tools, the criteria for their selection, and the specific features of their application, taking into account students' age-related characteristics, the content of educational materials, and expected learning outcomes.

Another defining feature is the integrative nature of professional knowledge, which enables future teachers to establish interdisciplinary connections, explain natural phenomena and processes on the basis of the principles of various sciences, use mathematical methods to process research results, and employ technological tools to solve learning problems. An important component is an understanding of the methodology of scientific inquiry, the principles of research-based learning, algorithms for experimental activities, and engineering design.

Knowledge of modern information and digital resources, virtual laboratories, digital measurement systems, geographic information systems, computer modeling tools, and data visualization technologies is becoming particularly important. Future teachers should not only be familiar with the variety of such tools but also understand their didactic potential, limitations, and appropriateness for teaching specific natural science disciplines. The development of the cognitive component is manifested in the systematic and conscious nature of professional knowledge, an understanding of the essence of the STEM approach, the ability to substantiate interdisciplinary connections, explain natural science principles, select information and digital resources, and apply knowledge to analyze complex learning situations.

The operational-activity component characterizes the practical readiness of future science teachers to implement STEM technologies in their professional activities and involves the development of a range of pedagogical, research, experimental, technological, and communication skills. Its essence lies in the ability to transform acquired theoretical knowledge into specific ways of organizing educational activities aimed at active exploration of natural phenomena, conducting research, and solving practical problems. The distinctive characteristics of this component include the need to master various methods and technologies of STEM learning, particularly problem-based and inquiry-based learning, experimental learning, project-based learning, heuristic learning, and practice-oriented learning.

Future teachers should be able to organize observations, laboratory investigations, measurements, modeling of natural processes, construction of educational objects, and work with digital laboratories and specialized software. Particular emphasis should be placed on the ability to organize productive interaction among participants in the educational process, ensure teamwork, coordinate research tasks, guide students towards independent information seeking, hypothesis testing, and the reasoned formulation of conclusions. At the same time, future teachers should be able to create safe conditions for experimental activities, use educational equipment efficiently, and adapt practical tasks to students' educational capabilities.

The impact of the operational-activity component is manifested in the ability to apply STEM technologies in practice, conduct educational experiments, use digital tools, organize research and teamwork activities, solve interdisciplinary tasks, and ensure the practical orientation of science teaching. The design-methodological component reflects a future teacher's ability to purposefully design a STEM-oriented educational process, develop methodological support for integrated learning, and determine the content, forms, methods, technologies, and means of implementing interdisciplinary educational tasks. It characterizes a teacher's readiness to independently design learning situations in which natural science knowledge is integrated with mathematical, technological, and engineering approaches to activity. Its distinctive feature lies in the need to combine subject-specific and methodological training with pedagogical design skills. Future teachers should be able to identify an educational problem, formulate objectives and expected learning outcomes, select interdisciplinary content, develop STEM tasks, determine the sequence of research activities, and establish criteria for assessing students' performance.

A leading area of implementation of this component is the development of original STEM projects, integrated lessons, educational research cases, practical tasks, and methodological scenarios in natural science disciplines. For example, future geography teachers may design tasks involving the geoinformation modeling of natural processes; biology teachers may develop research projects focused on studying ecosystems; and chemistry teachers may construct experimental tasks investigating the properties of substances and environmental safety.

The ability to select information and digital resources, laboratory equipment, software, and educational materials in accordance with the subject content, educational objectives, and resource capacities of an educational institution is of particular importance. Design and methodological activities also involve anticipating potential difficulties, identifying ways to differentiate tasks, taking into account students' individual educational needs, and planning the assessment of learning outcomes.

The development of the design-methodological component is manifested in the ability to develop STEM-oriented lessons, design interdisciplinary projects, create original methodological materials, make informed choices of pedagogical technologies, and ensure the coherence of the content-related, organizational, and technological components of the educational process.

The reflective-evaluative component characterizes a future teacher's ability to systematically analyze their own professional activities, evaluate the effectiveness of the STEM technologies applied, assess the quality of achieved educational outcomes, and identify areas for further professional improvement. Its content encompasses self-analysis, self-assessment, critical reflection on pedagogical experience, evaluation of learning activities, and adjustment of selected methodological decisions. The specific nature of this component in the context of STEM education lies in the need to evaluate not only the final outcome of a learning project but also the entire process of its implementation. Future teachers should be able to analyze how effectively students formulated research problems, put forward hypotheses,

conducted experimental activities, used digital tools, interacted in teams, and presented their findings. It is also important to emphasize proficiency in various methods of assessing STEM activities, including pedagogical observation, analysis of research reports, assessment of project outcomes, self-assessment, peer assessment, portfolios, and reflective discussions. This makes it possible to determine not only the level of mastery of educational components but also the dynamics of the development of students' research, communication, creative, and practical skills.

The reflective-evaluative component also involves the ability to critically assess one's own methodological decisions, identify difficulties encountered during the implementation of STEM tasks, and determine the reasons for the insufficient effectiveness of particular technologies. An important characteristic is an orientation towards continuous professional learning, self-development, the study of innovative teaching practices, and the improvement of one's own methodological expertise.

The development of the reflective-evaluative component is manifested in the ability to objectively analyze the outcomes of pedagogical activities, carry out self-assessment, determine the effectiveness of the STEM technologies applied, use feedback, and adjust methodological approaches. These aspects are presented in greater detail in Table 1.

Table 1

Content characteristics of the components of readiness of future science teachers to apply STEM-technologies in professional practice

Readiness Component	Brief Content Characteristics
Motivational and Value-Based	Reflects professional motivation, interests, values, and positive attitudes towards STEM education and the use of innovative teaching technologies.
Cognitive	Encompasses knowledge of STEM education, interdisciplinary integration, natural sciences, teaching methods, and digital technologies.
Operational and Activity-Based	Involves the practical application of STEM technologies, research methods, experimentation, modelling, and project-based learning.
Design and Methodological	Encompasses the ability to design STEM-oriented lessons, develop interdisciplinary projects, and select appropriate teaching methods, tools, and resources.
Reflective and Evaluative	Involves self-assessment, analysis of teaching effectiveness, evaluation of learning outcomes, and improvement of professional practice.
Information and digital competence of the teacher	The ability to navigate in the information space, receive infor-mation and operate with it in accordance with one's own needs and the requirements of a modern high-tech socie-ty.

**Source: Developed by the author based on a theoretical synthesis of the structural characteristics of future science teachers' readiness to apply STEM technologies in professional practice.*

Thus, the content of the professional training of future science teachers for the application of STEM technologies should encompass not only the acquisition of relevant knowledge and technological tools but also the development of sustained professional motivation, practical skills, methodological competence, and the ability to engage in reflective improvement of pedagogical activities. The interrelationship between the identified structural components ensures the integrity of this process and facilitates the transition from theoretical familiarization with STEM technologies to their conscious, substantiated, and systematic application in teaching.

The interaction of these components creates the prerequisites for developing comprehensive professional readiness to organize research-based and practice-oriented learning. Their consistent development throughout professional training contributes to the formation of a teacher capable of effectively implementing STEM approaches, fostering students' research and creative abilities, and ensuring that the educational process meets contemporary requirements.

CONCLUSIONS AND PROSPECTS OF FURTHER RESEARCH

Contemporary transformations in the system of higher pedagogical education necessitate rethinking the essence and content of the professional training of future science teachers, particularly in the context of implementing STEM technologies. In scientific research, professional training is viewed as a holistic, multifaceted process aimed at transforming the educational environment. «In the context of STEM education, these skills acquire particular importance, as they ensure the future teacher's ability to integrate knowledge of natural sciences, technology, engineering, and mathematics, as well as to organize students' research and project activities» (Martin, 2025). Therefore, understanding the structure of professional training as an integrative system is of particular importance. «The use of innovative STEM-based learning technologies will contribute to the more effective development of students' critical thinking skills and cognitive interests, encourage them to demonstrate imagination and creativity, and develop their ability to analyse problem situations quickly» (Chervinska, 2017). The structure of the professional training of future science teachers is considered as the unity and interrelationship of social, psychological, and pedagogical aspects implemented in the learning process.

The prospects for further research are focused on developing a structural-functional model for the professional training of future science teachers to apply STEM technologies in their professional activities.

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