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METHODOLOGY FOR DEVELOPING THE COMPETENCE OF FUTURE PHYSICS TEACHERS THROUGH THEORETICAL TRAINING SESSIONS

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Abstract: This article analyzes the issue of developing the competence of future physics teachers in the process of theoretical training from a scientific and methodological perspective. Within the framework of the study, the essence of the concept of competence, its main types, and the theoretical foundations for their formation in the system of physics education are elucidated. Furthermore, innovative approaches aimed at developing the methodological, scientific, information-communication, and reflective competences of future teachers during theoretical training sessions are proposed.

The article scientifically substantiates the stages of competence formation based on active learning technologies, interactive methods, problem-based learning, and an integrated approach. It also pays special attention to assessment and self-development mechanisms aimed at increasing the effectiveness of organizing theoretical training sessions.

The research findings contribute to aligning the professional training of future physics teachers with modern educational requirements, enhancing their creative and analytical potential, and ensuring their thorough preparation for practical training.

Keywords:: competence, theoretical training, physics teacher, methodology, innovative educational technologies, reflection, active learning, pedagogical approach, mentoring, assessment system.

Introduction: In the current era of globalization, the education system is recognized as a key factor in societal development. Digital technologies, scientific achievements, and new pedagogical concepts are fundamentally transforming the teaching profession. In particular, the development of professional competence among future teachers in fundamental disciplines such as physics is considered one of the most important tasks of modern education. Physics, as a subject, plays a crucial role in developing thinking skills, as it enables students to understand natural laws, model them, and apply them in practice.

In the Republic of Uzbekistan, the “Law on Education,” the “Development Strategy of the New Uzbekistan for 2022–2026,” and the concept for modernizing higher education emphasize enhancing teachers’ qualifications and competencies as a priority direction. From this perspective, equipping future physics teachers with modern pedagogical thinking, innovative technologies, and methodological approaches during theoretical training sessions has become an urgent and essential task.

Theoretical training sessions serve as a foundational stage in the professional development of future teachers. These sessions are not limited to acquiring theoretical knowledge; they also help students develop skills in independent analysis, logical reasoning, problem-solving based on scientific principles, and methodological thinking. Therefore, designing methodological approaches aimed at forming teaching competence, scientifically substantiating them, and enriching them with practical

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applications is considered one of the urgent tasks of modern pedagogy. Such a methodological system enhances teachers' ability to apply theoretical knowledge in real pedagogical situations and fosters innovative thinking and a reflective approach. As a result, theoretical training becomes not only a source of knowledge but also a practical preparation field that shapes the professional competence of future teachers.

This article analyzes the methodological foundations for effectively organizing the process of developing the competence of future physics teachers, as well as innovative approaches, active learning methods, integrated teaching forms, and assessment systems that can be applied in theoretical training sessions. The purpose of the article is to develop scientific and methodological recommendations aimed at enhancing the competence of physics teachers during theoretical training and to explore opportunities for their practical implementation.

Analysis.

Types of key approaches for developing methodological competence in theoretical training sessions

The first key approach for developing methodological competence in theoretical training sessions is **problem-based learning**. In this method, the teacher does not provide ready-made knowledge; instead, students are presented with a problematic situation. For example, questions such as "How would the force of gravity change if the Earth's rotation speed doubled?" encourage students to express their ideas, provide evidence, and engage in discussions with peers. As a result, analytical thinking, cause-and-effect reasoning, and the ability to draw conclusions based on scientific logic are developed.

The next approach is **constructivist learning**. In this approach, students do not receive knowledge in a ready-made form; instead, they construct it based on their own experiences and observations. For example, Newton's Second Law is studied not as a pre-given formula but discovered through experimental results. This process fosters independent inquiry, scientific thinking, and an intrinsic motivation to understand natural laws in students.

Organizing theoretical sessions into modules is a practical manifestation of the systemic-modular approach, which enables the step-by-step development of methodical competence during teacher training. Each module is logically interconnected, harmonizing elements of theoretical knowledge, discussion, small-scale projects, and reflection. This approach allows students to expand their knowledge systematically, while analyzing and applying what they have learned at every stage. In theoretical sessions organized by modules, the student is no longer a passive listener but becomes an active participant in the educational process. While studying a given topic, they not only acquire new knowledge but also analyze teaching methods, forms of organizing educational activities, and lesson structures. Furthermore, through the process of reflection, students can identify their mistakes and begin to draw independent conclusions regarding teaching practices. In this way, the systemic-modular approach organizes the educational process in a consistent, explanatory, and purposeful manner, developing students' methodical thinking, creativity, and self-improvement skills.

Interactive teaching methods in theoretical sessions play a crucial role in activating students' thinking processes, shaping their communication culture, and developing their ability to justify and defend their own ideas. Methods such as "Brainstorming," "Clustering," "Fishbone" (Cause-and-Effect analysis), and "Debate" engage students as active participants in the lesson and help transition from passive knowledge acquisition to active critical thinking.

For instance, when the "Brainstorming" method is applied to topics such as "Mechanical Vibrations" or "Thermal Conductivity," students generate a vast number of ideas in a short period and evaluate them based on scientific principles. This method enhances creative thinking and logical analysis.

The "Clustering" method is useful for visually demonstrating the interconnections between fundamental concepts in the topic of "Kinetic Theory of Gases."

The "Fishbone" technique allows for the identification of a cause-and-effect chain when analyzing questions such as "Why do real gases differ from ideal gases?"

The "Debate" method, when applied to the topic of "The Efficiency of Energy-Saving Technologies," divides students into two groups and develops their culture of defending scientific arguments.

The role of innovative technologies in theoretical sessions is also incomparable. The use of simulations and virtual laboratories creates opportunities for students to bridge theoretical knowledge with real-world phenomena. For instance, studying processes such as diffusion in gases or electromagnetic induction through virtual models further strengthens their theoretical understanding. This approach also provides great possibilities for the teacher—by utilizing visual and interactive elements in their lessons, they can explain complex processes in a simplified manner.

Another effective way to develop methodical competence is the reflexive approach. In this approach, students analyze their own learning activities during the lesson process by asking: "What did I learn today?", "Which method was effective?", and "What will I change next time?". Through such reflection journals, students shape their own teaching style, identify their strengths and weaknesses, and learn the art of self-development.

In recent years, the STEAM-integrated approach has been widely applied in education. In this method, physics is taught in connection with other disciplines—mathematics, technology, engineering, and art. For instance, by developing an ecological heating system project within the topic of "Heat Transfer," students learn not only the physical process but also its real-life applications. This forms the highest stage of methodical competence—creative and interdisciplinary thinking.

Furthermore, through mentoring and peer learning approaches, more experienced students participate in the process of teaching others. Each student, acting as a "mini-teacher," masters a specific subtopic and explains it to their peers. This process helps students effectively convey their knowledge to others, develop pedagogical speech, and envision themselves as real teachers.

Assessment systems in theoretical sessions should also be organized in a new way. Through portfolio and project-based assessment, students compile their lesson plans, analyses, experimental schemes, and reflections. This allows for the evaluation of not only the final result but also the dynamics of their professional growth.

Finally, the integration of digital technologies is an integral part of developing methodical competence. Platforms such as Canva, PhET, GeoGebra, Quizizz, ChatGPT, and Mentimeter increase interactivity in theoretical sessions, transforming the educational process into an engaging and modern format. Digital literacy is one of the core skills of a contemporary teacher.

In conclusion, the development of methodical competence is achieved through the effective organization of theoretical sessions, the use of active methods, reflection, interdisciplinary integration, and the implementation of digital technologies. As a result of these approaches, future physics teachers emerge as methodologically mature specialists who possess not only theoretical knowledge but also the ability to think independently, manage the educational process, and innovate.

The scientific competence of a future physics teacher is the ability to perceive scientific problems, analyze them, find solutions using scientific methods, analyze experimental results, and express conclusions on a scientific basis. Utilizing innovative approaches to develop this competence during theoretical sessions is one of the key factors in enhancing the effectiveness of the educational process.

The first innovative way to facilitate the formation of scientific competence is research-based learning. In this approach, students do not limit themselves to acquiring ready-made knowledge; instead, they conduct their own research on a scientific problem. For instance, a small-scale study is organized based on the question: "Which factors influence the thermal expansion of solids?" Students analyze theoretical concepts, formulate hypotheses, examine experimental results, and draw conclusions. Through this process, their scientific thinking, observational skills, and analytical reasoning are developed.

The second effective method is problem-based learning. Scientific competence begins not just with knowing information, but with asking questions and solving them through scientific methods. Therefore, in theoretical sessions, the teacher should not provide "ready-made answers." For example: "If atmospheric pressure were reduced by half, how would the boiling point of water change?" Students share their hypotheses and provide explanations based on theoretical principles and formulas. Through this, they learn to analyze cause-and-effect relationships and prove hypotheses and conclusions using scientific evidence.

The third approach is project-based learning (PBL). In this method, students develop a small-scale project based on a specific physical problem or phenomenon. Projects such as "Choosing optimal materials for thermal insulation," "A model for the efficient use of solar energy," or "Modern methods of measuring magnetic fields" allow students to test theoretical knowledge in a practical environment. Consequently, students master the stages of scientific methodology (stating the problem, setting goals, and analyzing results) through hands-on practice.

The fourth essential way is experimental learning. In theoretical sessions, the teacher does not leave experiments solely for practical classes but integrates them with theoretical analysis. For example, on the topic of "The relationship between gas pressure and volume," an experiment is conducted using virtual laboratories or simulation tools. By observing theoretical laws, plotting graphs, and analyzing data, students master the scientific approach.

The next approach is learning based on modeling and simulation. By modeling physical phenomena, students learn to perform theoretical analyses of complex processes. For instance, modeling processes such as "Molecular kinetic energy" or "Electromagnetic induction" through computer software expands students' scientific imagination. Through this method, they can prove cause-and-effect relationships using digital results.

Furthermore, integrative and interdisciplinary approaches also strengthen scientific competence. Teaching physics in connection with mathematics, computer science, chemistry, or technology forms

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complex scientific thinking in students. For instance, through sessions such as "The mathematical model of the heat transfer process" or "Analyzing mechanical vibrations using computer software," students are able to perceive various interdisciplinary connections.

Critical thinking and analytical reasoning methods also play a significant role in developing scientific competence. During lessons, through questions such as "Why?", "How?", and "What if it were not so?", students are taught to deeply analyze causes. This method develops their ability to think independently, provide evidence, and critically analyze theoretical foundations.

Furthermore, it is essential to cultivate a culture of scientific writing and presentation. Students express the results of their scientific observations in written form and learn to present data through graphs, tables, and diagrams. This skill serves as a foundation for their future preparation of scientific articles, abstracts, and conference papers.

Furthermore, through reflexive and metacognitive approaches, students analyze their own learning activities, identifying what they know, what they have not yet understood, and what they need to learn in the next stage. Such an approach develops the skills of self-improvement, inquiry, and critical self-assessment.

In general, developing scientific competence in theoretical sessions is not about memorizing knowledge, but rather about forming a culture of analyzing, experimentally proving, and scientifically substantiating it. Through the complex application of innovative methods such as problem-based learning, research-oriented education, project work, modeling, digital technologies, interdisciplinary integration, and reflexive analysis, future physics teachers emerge as specialists with modern scientific thinking, analytical reasoning skills, and the ability to make decisions based on scientific evidence.

Information and Communication Competence (ICC) for future physics teachers is one of the core professional capacities essential for operating in a modern educational environment. It signifies a teacher's ability to integrate digital technologies into the learning process, utilize information sources effectively, possess a culture of online communication, and implement digital innovations in education.

To develop the Information and Communication Competence (ICC) of future teachers in theoretical sessions, it is essential to utilize various innovative approaches. Such approaches not only make the lesson process engaging but also foster students' skills in independent thinking, critical analysis, and the rational use of modern educational tools.

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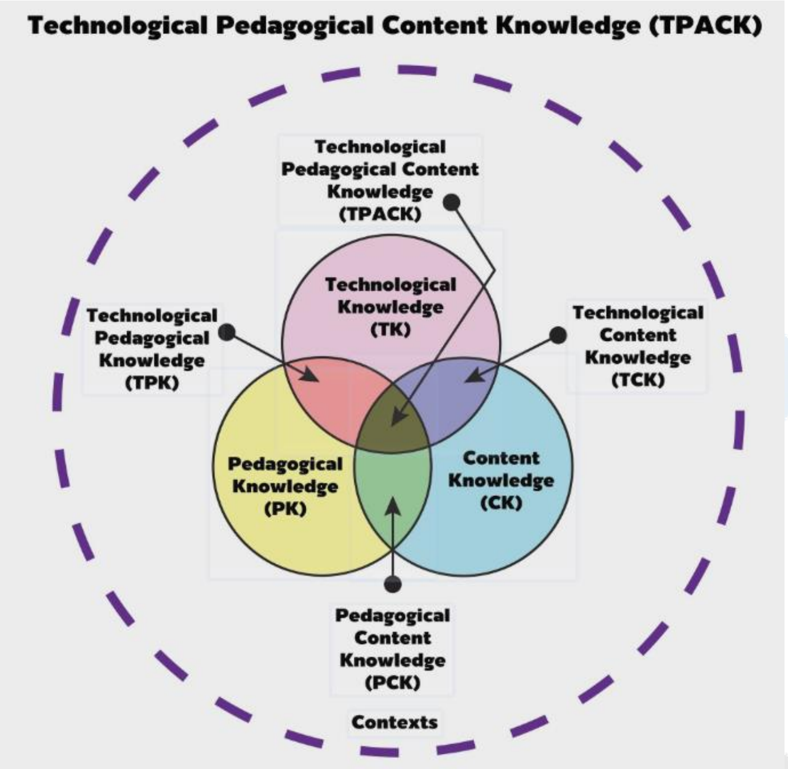

Firstly, an approach focused on utilizing a digital learning environment is of significant importance. In this approach, students use electronic resources, educational platforms, and simulation software instead of traditional textbooks. For instance, when studying the "Kinetic Theory of Gases," visually observing molecular motion through PhET simulations provides students with a deeper understanding. Similarly, in the topic of "Heat Exchange," demonstrating phenomena through scientific YouTube channels or interactive videos facilitates the development of ICC.

Secondly, an approach based on information retrieval and analysis enhances students' independent research activities during theoretical sessions. Students find necessary scientific information on platforms such as Google Scholar and ResearchGate, analyze them, and compare sources for reliability. For instance, by studying various scientific articles on topics like the "Van der Waals equation" or "Real gases," students can bridge the gap between theoretical concepts and actual scientific research.

The third approach is collaborative learning based on cloud technologies. In this method, students perform theoretical tasks together using digital tools such as Google Docs, Canva, Padlet, or Jamboard. For example, on the topic of "Laws of Electrostatics," students can jointly create infographics on the Canva platform, or prepare a presentation on "Fundamental Laws of Mechanics" using Google Slides. Through this, they master the culture of teamwork, online communication, and the exchange of ideas.

Fourthly, the use of virtual laboratories and simulation environments develops the skill of connecting experiments with theoretical analysis in future teachers. For instance, using the PhET Circuit Construction Kit for the topic of "Ohm’s Law," or software like GeoGebra PhysLab and Algodoo for "Magnetic Fields," enables students to conduct scientific analysis in an interactive environment. Consequently, students acquire skills in computer modeling of experiments, analyzing results, plotting graphs, and drawing scientific conclusions.

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Fifthly, the multimedia approach allows for the explanation of complex physical processes in both visual and auditory forms during theoretical sessions. For example, creating animations using Adobe Animate for the topic of "Interference of Light," or working with 3D models for "Superposition of Waves," engages students not just as listeners but as active participants.

Furthermore, interactive testing and assessment systems play a vital role in developing ICC. For instance, conducting tests through Quizizz or Kahoot on the topic of "Amount of Heat and Conservation of Energy" teaches students to adapt to digital assessment systems. Similarly, organizing online surveys using Mentimeter on the topic of "Mechanical Vibrations" encourages interactive thinking.

The next crucial path is the information design and visualization approach. In this approach, students represent information in the form of graphs, diagrams, or infographics. For instance, by creating infographics using Canva or Piktochart on the topic of "Types of energy and their mutual transformation," they learn to simplify and aesthetically represent complex data.

Another effective method is the use of social networks and open educational platforms. Future teachers expand their scientific outlook by completing short courses on platforms such as Coursera, edX, and Udemy. For example, studying international educational modules on topics like "Applications of quantum physics" or "Solar energy utilization" prepares them for modern technological approaches.

Furthermore, the use of Artificial Intelligence (AI) tools in modern education is opening a new stage in the development of ICC. Through AI platforms like ChatGPT, Copilot, and Gemini, students can generate explanations, examples, or test questions on theoretical topics. For instance, using AI to simplify and explain complex formulas in the topic of "Maxwell's equations" provides significant assistance in teaching activities.

Finally, the approach of digital reflection and self-development is highly effective in the final stages of theoretical sessions. By maintaining learning journals on platforms such as Google Sites, Notion, or Blogger, students answer questions like "What did I learn today?" and "Which technology was most useful?" Through this process, they learn to analyze their activities and independently determine their direction for further development.

In conclusion, innovative approaches aimed at developing Information and Communication Competence (ICC) increase the efficiency of theoretical sessions, adapt the teacher's persona to the digital world, and form modern technological thinking in students. PhET simulations, Canva design platforms, Google Workspace, ChatGPT, virtual laboratories, online testing systems, and interdisciplinary cloud collaboration—all of these profoundly develop the ICC potential of future teachers. Consequently, they emerge as innovative thinkers and specialists capable of effectively managing information and applying digital tools for pedagogical purposes within the educational process.

Reflexive competence is a future teacher's ability to analyze and evaluate their own activities, identify and correct errors, and strive for self-development. It serves as a crucial indicator of a teacher's professional maturity and must be cultivated during theoretical sessions. Since physics education is theoretically complex and requires logical thinking, developing reflexive competence in this process creates a solid foundation for the teacher's future pedagogical activity.

Several innovative approaches yield effective results in developing reflexive competence during theoretical sessions. These approaches shape the teacher into a specialist who views their own knowledge and activities critically and makes decisions based on analysis.

Firstly, reflexive learning technology directs the teacher toward analyzing their own learning process. By asking students questions such as "What did I learn today?" and "Where did I face difficulties?" at the end of a lesson, they analyze their learning experience. For example, on the topic of the "Law of Conservation of Mechanical Energy," a student might express their thoughts in writing: "I understood the conservation of energy, but I confused the kinetic energy formula." Such an analysis forms the student's culture of self-assessment and learning from mistakes.

Secondly, the metacognitive approach deepens reflexive thinking. In this approach, the student also analyzes their own thought process; that is, they do not just learn, but also perceive how they are learning. For example, in the topic of "Kinetic Theory of Gases," a student might analyze their learning process by writing: "It was difficult to visualize molecular collisions, so I used an animation." In this way, the student monitors their own learning strategy and learns to find the most effective path.

The third effective method is portfolio-based learning. The student compiles their work—lesson plans, analyses, reflection entries, experimental results, and observations—in one place. During the process of studying "Molecular Physics," short entries such as "the core idea learned today" or "which method was useful" are added to the portfolio after each lesson. This method allows students to track their own growth, evaluate their development process, and analyze their activities.

Fourthly, the peer-reflection approach also develops reflexive competence. Students analyze each other's work and identify strengths and weaknesses. For instance, on the topic of "Electromagnetic Induction," each student prepares a short presentation, followed by feedback from peers. This process teaches students to look critically not only at their own work but also at the activities of others. Consequently, a culture of providing constructive feedback, assessment, and analysis is formed among students.

Fifthly, the digital reflection approach enables self-analysis to be carried out in a digital environment. Students maintain a "Reflection Diary" on platforms such as Google Sites, Notion, or blog platforms. For example, after each lesson on "The Solar System and Laws of Motion," a student writes answers to questions like "What new thing did I learn today?", "What amazed me?", and "What needs to be changed?" This method develops the skills of regular analysis, expressing one's thoughts in written form, and self-improvement.

Sixthly, the problem-situation approach strengthens reflection through real pedagogical scenarios. For instance, on the topic of "Archimedes' Principle," the instructor presents a situation: "A student expressed an incorrect opinion regarding the reason objects float in a liquid. As a teacher, how would you explain it?" Students analyze this scenario and defend their solutions. In this way, they learn to analyze their own thinking, identify errors, and correct them.

Seventhly, reflexive seminar-trainings are based on group discussions of the reflection process. For example, at the conclusion of a seminar on "The Second Law of Thermodynamics," students answer questions such as "Which of my views have changed?" or "Which examples gave me a new understanding?" As a result of such group discussions, students review their knowledge, exchange ideas, and draw new conclusions based on analysis.

Eighthly, reflection using Artificial Intelligence (AI) tools has introduced a new quality to the modern educational process. Tools such as ChatGPT and Copilot analyze the text written by the student, point out errors, and provide suggestions. For instance, on the topic of "Gas Pressure and Temperature," a student might ask the AI, "Did I explain this law correctly?" The AI analyzes the response and provides feedback. This automates the reflection process and enhances the student's capacity for critical analysis.

Finally, the reflection diary method is one of the simplest yet most effective techniques. After each lesson, the student writes answers to three questions in their notebook: "What did I learn?", "What made me think?", and "What needs to be improved?". For example, a diary entry based on these questions following the topic of "Heat Balance" helps the student analyze their own learning process.

In conclusion, developing reflexive competence means a teacher analyzing their own knowledge, evaluating the lesson process, learning from mistakes, and striving for continuous growth. Utilizing reflexive learning technology, the metacognitive approach, portfolios, peer-reflection, problem-situation scenarios, and digital reflection methods during theoretical sessions teaches a profound analysis of teaching activities. As a result of these approaches, future physics teachers emerge as specialists capable of conscious self-analysis, critical thinkers, creative individuals, and professionals ready for continuous self-development.

Result.

As a result of developing methodological, scientific, information-communication, and reflexive competencies during theoretical sessions, future teachers experience complex growth in professional, intellectual, and personal aspects. These competencies are intrinsically interconnected, and their harmonious development ensures that the physics teacher emerges as an independent-thinking, innovative individual, fully prepared for the modern educational environment.

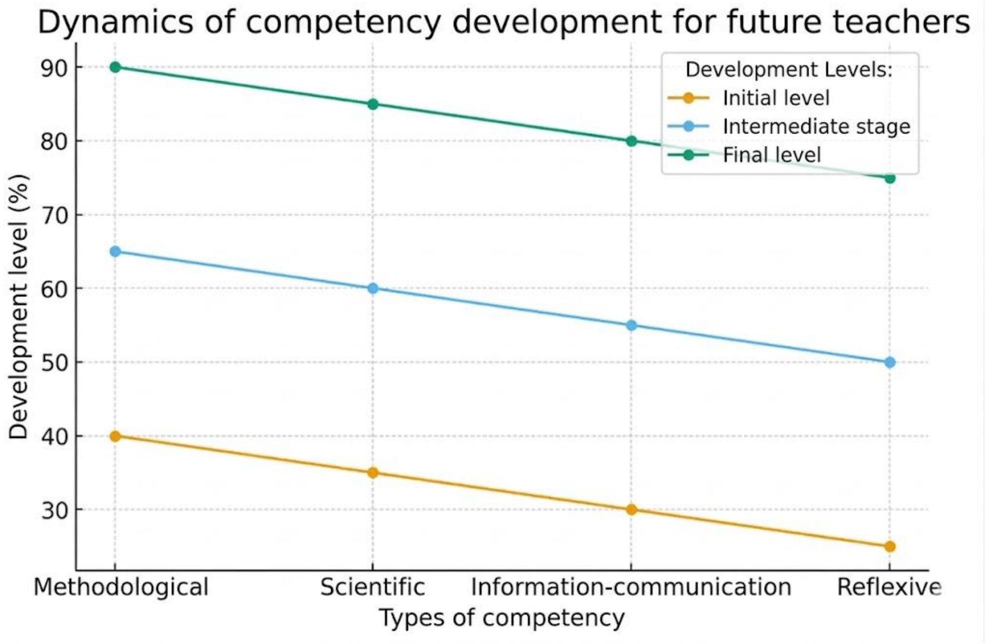

Figure 1. Indicators of methodological, scientific, information-communication, and reflexive competencies of future physics teachers across initial, intermediate, and final stages.

General Concluding Summary

As a result of the complex development of these four competencies during theoretical sessions, the following integrative professional qualities are formed in the future physics teacher:

- Scientific-Methodological Harmony: The ability to bridge theoretical knowledge with practical application.
- Innovative Thinking: Readiness to implement new technologies and pedagogical methods.
- Analytical Reasoning: The capacity to identify cause-and-effect relationships and approach problems systematically.
- Communicative Potential: Effective interaction with students, colleagues, and the digital environment.
- Professional Reflection: Analyzing one's own activities to determine a path for continuous improvement.

Thus, when these competencies are developed, the physics teacher emerges not merely as a conveyor of knowledge, but as a researcher, analyst, creator, and digitally-minded educator. They transform into a specialist who can analyze every lesson, is ready to introduce innovations, and stays in step with the demands of modern education.

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