



## **Didactic Possibilities Of Integrating General Pedagogy And The Methodology Of Teaching Physics And Astronomy In Developing Future Teachers' Methodological Competence**

**Berdiyev Shokir Xudoynazarovich**

Chirchik State Pedagogical University, Senior Lecturer of the Department of Physics

**Abstract:** This paper examines the didactic possibilities of integrating General Pedagogy with the Methodology of Teaching Physics and Astronomy in the preparation of future teachers. The study is based on a design-oriented analysis of the dissertation plan for the 60110700 - Physics and Astronomy educational direction, where methodological competence is interpreted as a system of cognitive-integrative, lesson-design, practical-methodological, digital-methodological, communicative, and diagnostic-reflective components. The research aim is to clarify how general pedagogical concepts such as learning objectives, teaching methods, assessment, STEAM education, problem-based learning, case study, project work, and reflection can be connected with physics and astronomy teaching tasks. The methodology relies on document analysis, competence mapping, and construction of an integration chain: pedagogical concept - physics or astronomy topic - methodological problem - digital tool - assessment - reflection. The results present an integration matrix and a set of competence-oriented tasks, including lesson plans, methodological cases, virtual laboratory analysis, PISA-type assignments, STEAM projects, and reflective portfolios. The discussion shows that such integration can make teacher preparation more coherent, practice-oriented, and measurable. The article concludes that systematic integration of pedagogical theory and subject methodology is a necessary didactic condition for developing future physics and astronomy teachers' methodological competence.



**Keywords:** methodological competence; future physics teachers; general pedagogy; physics and astronomy teaching methodology; interdisciplinary integration; digital didactics

## Introduction

The professional training of future physics and astronomy teachers requires more than the acquisition of theoretical knowledge in physics, astronomy, and pedagogy. A future teacher must be able to transform scientific content into a clear learning goal, select a suitable teaching method, organize practical or laboratory activity, assess learners' achievements, and reflect on the quality of his or her own methodological decisions. For this reason, methodological competence is one of the key outcomes of teacher education in the 60110700 - Physics and Astronomy educational direction.

In many teacher preparation programs, General Pedagogy and the Methodology of Teaching Physics and Astronomy are taught as separate courses. This separation is convenient for curriculum organization, but it can weaken the connection between pedagogical theory and subject-specific teaching practice. For example, students may study the concept of problem-based learning in pedagogy, but may not immediately understand how to use it when teaching Newton's laws, electric circuits, optical phenomena, or astronomical observation. Likewise, they may learn the structure of a physics lesson without connecting it to assessment rubrics, reflective portfolios, or digital learning tools.

The dissertation plan used as the basis for this article proposes a direct integration of General Pedagogy and the Methodology of Teaching Physics and Astronomy through the MethodEdu.uz adaptive digital learning platform. The central idea is that integration should not remain a general slogan. It must be expressed in concrete learning modules, methodological cases, virtual laboratories, PISA-type tasks, STEAM projects, diagnostic tests, competence maps, and reflective portfolios.

The purpose of this article is to identify the didactic possibilities of such integration and to show how it may contribute to the development of future teachers' methodological competence. The article follows the IMRAD logic by presenting the theoretical background, research design, main design results, discussion, and conclusion.



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## Literature Review

The concept of teacher competence is closely related to the ability to combine knowledge, skills, attitudes, and professional judgment in real pedagogical situations. Shulman's theory of pedagogical content knowledge emphasizes that effective teaching requires not only subject knowledge and general pedagogical knowledge, but also knowledge of how a particular subject should be taught to particular learners. In physics education this idea is especially important because many concepts are abstract, mathematical, experimental, and connected with real technological processes.

The TPACK framework developed by Mishra and Koehler expands this idea by adding technology as an essential component of teacher knowledge. In the context of physics and astronomy teacher education, technological pedagogical content knowledge is expressed in the ability to use simulations, virtual laboratories, digital tests, online portfolios, data visualization tools, and AI-supported feedback for methodological purposes. Therefore, digital competence should not be treated separately from methodological competence; it should be embedded in lesson design, classroom interaction, assessment, and reflection.

Competence-based and activity-based approaches also support the integration of theory and practice. A competence-oriented curriculum requires that students solve real professional tasks rather than only reproduce definitions. In teacher education, such tasks may include designing a lesson plan, explaining a physics experiment to school learners, creating a PISA-type problem, evaluating a laboratory report, or developing a STEAM project. These tasks connect General Pedagogy with subject methodology and make the learning process closer to future professional activity.

Recent discussions about digital learning environments and AI-supported education show that teacher education should prepare students for responsible and reflective use of digital tools. However, digital tools become pedagogically meaningful only when they are connected with clear didactic goals. Therefore, the integration of General Pedagogy and the Methodology of Teaching Physics and Astronomy should be supported by a digital-didactic environment that provides content, tasks, assessment, monitoring, and reflection in one coherent system.



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## Methodology and research design

**Research design:** This article is a theoretical and design-oriented study. It does not report a completed pedagogical experiment; instead, it develops a didactic integration model on the basis of the dissertation plan, qualification requirements, and the logic of the two professional courses. The main research question is: how can General Pedagogy and the Methodology of Teaching Physics and Astronomy be integrated in order to develop future teachers' methodological competence?

**Analytical procedure:** The research procedure consisted of four steps. First, the expected competence components of a future physics and astronomy teacher were identified. Second, the content of General Pedagogy was grouped into didactic categories: learning objectives, methods, forms of instruction, assessment, STEAM, problem-based learning, case study, project activity, digital technologies, and professional reflection. Third, the content of the subject methodology course was grouped around physics and astronomy lesson design, laboratory work, problem solving, interdisciplinary links, PISA tasks, and teaching of mechanics, electricity, molecular physics, optics, and astronomy. Fourth, both groups were connected through professional tasks and digital tools.

**Design criterion:** The main criterion for integration was professional usefulness. A pedagogical concept was included in the integration matrix only if it could be transformed into a subject-methodological task. For example, the pedagogical concept of assessment was connected with physics test construction, PISA-type tasks, laboratory report rubrics, and competence mapping. The concept of project-based learning was connected with STEAM projects in astronomy and physics. The concept of reflection was connected with lesson analysis and portfolio writing.

**Digital-didactic orientation:** The MethodEdu.uz platform was considered as the digital environment in which the integration can be implemented. In this environment, each integrated task is connected with an electronic module, interactive assignment, virtual laboratory, diagnostic test, portfolio, competence map, adaptive recommendation, or AI assistant. The platform is therefore interpreted not only as a technical tool, but also as a methodological constructor.



## Research Results

The first result of the analysis is the clarification of the integration chain. It begins with a competence indicator and continues through a pedagogical concept, a physics or astronomy methodological topic, a professional task, a digital tool, assessment, and reflection. This chain makes it possible to transform abstract pedagogical knowledge into a practical subject-methodological product.

**Table 1**

**Integration map of General Pedagogy and the Methodology of Teaching Physics and Astronomy.**

General pedagogy focus	Physics and astronomy methodology focus	Integrated task	Competence component
Learning objectives and outcomes	Structure of a physics topic	Module passport and expected outcomes	Cognitive-integrative
Teaching methods and visual tools	Mechanics, electricity, optics experiments	Method selection and demonstration plan	Practical-methodological
Problem-based and case learning	Typical learner mistakes in physics	Methodological case solution	Practical-methodological
STEAM and project learning	Astronomy and interdisciplinary links	STEAM project design	Communicative and creative
Assessment and diagnostics	PISA tasks, tests, laboratory reports	Rubric and diagnostic task	Diagnostic-reflective
Professional reflection	Lesson and laboratory analysis	Reflective portfolio entry	Diagnostic-reflective



The second result is the identification of six competence components that can be developed through integrated tasks. The cognitive-integrative component is developed when students connect pedagogical theory with physical and astronomical content. The lesson-design component is formed when they plan objectives, expected outcomes, methods, resources, and assessment. The practical-methodological component is strengthened through lesson plans, cases, demonstrations, and laboratory analysis. The digital-methodological component grows when students use virtual laboratories, tests, interactive resources, and AI-supported recommendations for teaching purposes.

The communicative component is developed through discussion, group project work, explanation of physical phenomena, and peer feedback. The diagnostic-reflective component is formed when students create rubrics, evaluate learning results, analyze mistakes, and write reflective portfolio entries. Thus, integration affects not only knowledge, but also professional action and self-assessment.

The third result is a system of integrated assignments. The most productive assignment types are lesson plan development, methodological case analysis, virtual laboratory interpretation, PISA-type problem construction, STEAM project design, and reflective portfolio writing. Each assignment requires students to use both pedagogical reasoning and subject-methodological thinking.

### **Discussion**

The results show that the integration of General Pedagogy and the Methodology of Teaching Physics and Astronomy can reduce the gap between theoretical preparation and professional practice. When students learn pedagogical concepts in isolation, these concepts may remain formal. When the same concepts are applied to concrete physics and astronomy topics, they become professional tools. For example, the concept of visibility becomes meaningful when it is connected with optical experiments, simulations, or astronomical models. The concept of formative assessment becomes practical when it is connected with a rubric for evaluating a laboratory report.

The proposed integration also corresponds to the logic of modern physics education, where conceptual understanding, experimental activity, modeling, problem solving, and digital visualization are closely connected. A future teacher who can design an integrated learning task is more likely to organize an active



lesson, explain complex phenomena in accessible form, and evaluate learners' progress according to clear criteria.

At the same time, integration requires careful instructional design. It is not enough to place two course topics next to each other. The teacher educator must define the competence outcome, select a relevant physics or astronomy topic, formulate a methodological problem, choose an appropriate digital resource, and prepare an assessment rubric. The MethodEdu.uz platform can support this process because it allows modules, tasks, tests, portfolios, and competence maps to be connected within one environment.

A limitation of the present article is that it presents a design result rather than empirical evidence from a completed experiment. Therefore, the next stage of research should involve diagnostic testing, implementation in experimental and control groups, and statistical analysis of competence growth.

### **Conclusion**

The integration of General Pedagogy and the Methodology of Teaching Physics and Astronomy is a significant didactic condition for developing future teachers' methodological competence. Such integration helps students move from knowing pedagogical definitions to applying them in concrete physics and astronomy teaching situations. The proposed integration chain and task system make the training process more coherent, practice-oriented, digital, and reflective.

The main practical recommendation is to design every professional module as a connection between a pedagogical concept, a subject-methodological topic, a digital tool, an assessment criterion, and a reflective product. In this way, students learn not only what to teach, but also how to teach, how to evaluate, and how to improve their own methodological decisions. Future research should test the proposed integration model in real teacher education groups and analyze the results with mathematical-statistical methods.

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