METHODOLOGICAL PRACTICES OF THE PRYKARPATTIA SCHOOL OF PHYSICS IN THE CONTEXT OF THE MODERN EDUCATIONAL PARADIGM

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Abstract

The article presents a comprehensive analysis and scholarly-methodological reinterpretation of the innovations of the Prykarpattia School of Physics, founded at the Ivano-Frankivsk Pedagogical Institute (now Vasyl Stefanyk Precarpathian National University), with an emphasis on their potential for adaptation to the modern competency-based and digital educational paradigm. The point of departure is the identification of current problems in the practice of teaching physics in Ukraine: formalized acquisition of knowledge, insufficient experimental training, fragmentation of learning material, and the need to combine digitalization with the continuity of proven didactic models. It is shown that the methodological approaches of the school's representatives (H. Haiduchok, P. Kyrychok, I. Luchkiv, and others) in the 1970s–1980s were ahead of widespread practices and remain relevant to the contemporary priorities of the New Ukrainian School: the development of critical thinking, research skills, technological literacy, and the applied use of knowledge.

It is substantiated that H. M. Haiduchok's idea of generalized experimental skills can be naturally scaled through digital laboratories, interactive simulations, and STEM projects. At the same time, AI tools can personalize the experimental learning trajectory, diagnose learning difficulties, and shift from the "fixation of an error" to its explanation and correction. Approaches to the differentiation of experimentation (H. Haiduchok) are interpreted as a methodological prototype of adaptive learning, particularly relevant in inclusive and distance education. P. P. Kyrychok's positions on the fundamentalization of teacher training align with the need for modern pedagogical education to integrate scientific, practice-oriented, and technological components. It is concluded that the legacy of the Prykarpattia School of Physics constitutes an effective methodological resource for modernizing physics education in schools, professional colleges, and universities amid digital transformation and the development of AI.

Keywords: Prykarpattia school of physics, physics education methodology, generalized experimental skills, digital laboratories, STEM education, adaptive learning, artificial intelligence, competence-based approach.

Introduction. The development of physics teaching methodology in Ukraine is taking place against the backdrop of rapidly changing educational standards, digitalization, and the growing demand for competence-based learning outcomes. At the same time, educational practice continues to face persistent problems, including the formalized assimilation of knowledge, insufficient experimental training, and the fragmented presentation of instructional material. In this context, there is a pressing need to reconsider national methodological traditions capable of providing instruments for renewing the content and technologies of physics teaching without breaking with well-established didactic models [4]. A significant resource for such reconsideration is the legacy of the Prykarpattia School of Physics, formed at the Ivano-Frankivsk Pedagogical Institute (now Vasyl Stefanyk Precarpathian National University), whose representatives, notably H. M. Haiduchok, P. P. Kyrychok, and I. M. Luchkiv, proposed, in the 1970s and 1980s, approaches that were ahead of the dominant educational practices of their time. Although these methodological proposals were developed several decades ago, they have not lost their relevance, as they align with the current priorities of the New Ukrainian School: the development of critical thinking, inquiry skills, technological literacy, and the ability to apply knowledge in practical situations. The problem is that these achievements often remain confined to the "archives" of historical pedagogy, whereas contemporary technical means enable them to be translated into applied educational solutions.

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The scholarly relevance of this study is determined by the need to demonstrate how H. M. Haiduchok's idea of developing generalized experimental skills can be implemented through digital laboratories, STEM projects, and interactive simulations, while also being enhanced by artificial intelligence tools that individualize learning trajectories [3]. It is equally important to analyze the line of instructional technologization developed by H. M. Haiduchok and I. M. Luchkiv, namely, technical teaching aids, programmed assessment, and rapid feedback [6], which, in the contemporary educational environment, can evolve from the mere "identification of an error" to its explanation and personalized correction through learning analytics and generative models. Approaches to the differentiation of experimental activity proposed by H. M. Haiduchok and V. H. Nyzhnyk also require separate consideration, as they acquire new significance under the conditions of inclusive education and distance learning formats [7]. No less relevant is the methodological training of teachers and the concept of "scientific school studies" emphasized by P. P. Kyrychok, since contemporary teacher education requires models that combine fundamental academic grounding, practice orientation, and technological competence [5]. Thus, the scholarly problem consists in identifying ways to adapt the innovations of the Prykarpattia School to contemporary digital conditions and in demonstrating their applied value for the educational process not only in school education, but also in professional colleges and universities.

The purpose of the article is to provide a comprehensive analysis and scholarly-methodological reinterpretation of the methodological practices of the Prykarpattia School of Physics, in particular its approaches to the development of generalized experimental skills, the technologization of instruction and programmed assessment, the differentiation and individualization of learning activities, the methodological training of teachers, and the integration of knowledge into a holistic scientific worldview, to identify the possibilities for their adaptation and implementation in the contemporary educational process of schools, professional colleges, and universities through digital platforms, virtual laboratories, STEM tools, and artificial intelligence technologies.

Methods. The study employs historical-pedagogical and historical-genetic methods to reconstruct the formation of the Prykarpattia methodological school of physics and the evolution of its approaches from programmed instruction practices and technical teaching aids to contemporary digital solutions. The methods of analysis and synthesis are used to identify the key methodological innovations, namely, the development of generalized experimental skills, programmed assessment and feedback, the differentiation of experimental activity, the fundamentalization of teacher training, and the integration of knowledge, and to establish their logical connections with the competence-based paradigm of the New Ukrainian School. A comparative method is applied to correlate the approaches proposed in the 1970s and 1980s with contemporary practices, including STEM, digital laboratories, interactive simulations, adaptive learning, and elements of COIL, and to determine their didactic equivalence. The method of theoretical modeling (instructional design) is employed to formulate possible ways to implement the school's ideas on digital platforms and through the use of artificial intelligence tools to personalize learning trajectories and diagnose learning difficulties. In addition, an interpretive-hermeneutic approach is applied to examine the content of the works and methodological recommendations of the school's representatives, taking into account their historical context and the potential for contemporary reinterpretation.

Results. The development of the national methodology of teaching physics may be understood as a continuous historical process in which each stage not only reflects the demands of its era but also creates the preconditions for subsequent didactic transformations. A particularly prominent center of such development was the Prykarpattia School of Physics, established at the Ivano-Frankivsk Pedagogical Institute (now Vasyl Stefanyk Precarpathian National University). Its representatives, in particular H. M. Haiduchok, P. P. Kyrychok, and I. M. Luchkiv proposed several approaches to renewing the content, organization, and technologies of physics teaching, which, in the 1970s and 1980s, were ahead of the prevailing educational practices and at the same time laid down methodological guidelines consonant with the current priorities of competence-based education and digitalization. For this reason, the innovations of the Prykarpattia School may be reinterpreted as a methodological resource for the development of contemporary educational practices, including the use of artificial intelligence technologies.

One of the school's conceptual innovations was H. M. Haiduchok's idea of developing generalized experimental skills and abilities [3]. Its central emphasis was that, under conditions of scientific and technological advancement, what becomes decisive is not the mere sum of reproduced theoretical information, but the student's ability to organize experimental activity: to select and set up instruments, control experimental parameters, interpret results, assess errors, and draw well-grounded conclusions. The contemporary educational paradigm reproduces this logic through the development of scientific and technological competencies, while its practical implementation is increasingly associated with interactive simulations, STEM projects, and digital laboratories. Given that H. Haiduchok's concept placed significant emphasis on the staged character of learning activity and differentiated support for the learner [1], the potential of artificial intelligence may be employed for the individualization of learning: algorithms are capable of tracking the trajectory of performing a virtual experiment, identifying typical difficulties, and providing targeted prompts at the stages where errors occur, thereby reproducing the methodological idea of pedagogical "scaffolding" and support for learning progress.

A second important line of innovation within the Prykarpattia School was the introduction of technical teaching aids and programmed assessment of knowledge. In the works of H. M. Haiduchok and I. M. Luchkiv, the structure of lectures was described as an integral cycle consisting of an introductory, main, and concluding part, within which special control devices were used to provide rapid feedback on students' mastery of the material [6]. In its historical context, such solutions may be regarded as prototypes of modern learning management systems oriented toward the prompt diagnosis of learning outcomes and the correction of learning activity. The distinctive feature of the contemporary stage lies in the fact that artificial intelligence is capable of moving from mere error detection to error explanation: not simply identifying an incorrect answer, but determining its probable cause, that is, a typical misconception or a gap in understanding, and automatically offering personalized learning material to eliminate the identified problem. At the same time, the idea of intensifying independent work, which the school's methodologists associated with technical teaching aids, acquires additional possibilities in the digital environment: generative models can sustain educational dialogue, assist in constructing virtual models, explain physical phenomena in different ways, and stimulate argumentation, thereby developing the format of the "lecture-conversation", in which the technological tool functions not as a passive carrier of illustrations but as an interactive participant in cognitive interaction.

An organic continuation of the technologization of instruction within the Prykarpattia School was its attention to the differentiation and individualization of experimental activity, particularly in the works of H. M. Haiduchok [2]. In substantiating a differentiated approach to frontal experimentation, these scholars proposed additional tasks for more advanced students, support cards for those requiring assistance, and home experiments as a form of independent inquiry. Under contemporary conditions of inclusive education and the spread of distance-learning formats, these solutions align with the logic of adaptive learning, in which the level of difficulty and types of tasks are selected in accordance with the learner's academic achievements and educational needs. The practical equivalent of paper-based "cards" is now represented by interactive worksheets and digital platforms that can modify the learning trajectory based on task performance results. Virtual laboratories, in turn, make it possible to reproduce experimental situations of varying complexity and provide a space for creative inquiry in which the learner can make personal "discoveries" through planning the experimental procedure, varying parameters, and interpreting data, which corresponds to the heuristic orientations embedded by the methodologists of the Prykarpattia School.

A distinct and methodologically significant dimension of the legacy of the Prykarpattia School of Physics is associated with its understanding of teacher training as a holistic process that combines profound subject-matter competence, methodological culture, and the capacity for pedagogical reflection. In the works of P. P. Kyrychok and his colleagues, the idea was consistently affirmed that high-quality professional training for the future physics teacher cannot be limited to mere assimilation of specialized discipline content. It must rest on a high level of scientific and theoretical instruction, the systematic comprehension of teaching methodology, a continuous connection between pedagogical theory and school practice, and the formation, in the future teacher, of the ability to analyze the educational process as a complex, dynamic, and scientifically organized system. It is precisely in this context that the development of a specific form of "scientific school studies" within teacher education acquires significance, since it oriented students not only toward mastering instructional material, but also toward understanding the regularities governing the functioning of the school, the logic of lesson construction, the specific features of organizing the learning environment, and the mechanisms through which students' cognitive activity is formed.

A substantial role in implementing this approach was played by methodological seminars, which were not auxiliary elements of training but served as a full-fledged instrument of the future teacher's professional development. It was through seminar work that the discussion of typical difficulties in teaching physics, the analysis of the content of school curricula, the testing of methodological solutions, the reflection on the results of pedagogical observations, and the generalization of best practices were ensured. Such a model contributed to the fundamentalization of professional training, since the future teacher was formed not as a narrow transmitter of knowledge, but as a teacher-researcher capable of selecting teaching methods in a reasoned manner, designing educational situations, and critically evaluating their own practice. Under contemporary conditions, this approach has not lost its relevance; on the contrary, it has acquired new meaning. Higher education today operates within the framework of modular-rating technologies, the credit-modular organization of the educational process, the competence-based approach, and the growing role of practice-oriented models of professional training. Under such circumstances, the ideas of the Prykarpattia School may be reinterpreted as a methodological foundation for combining academic fundamentalization with pedagogical mobility, digital literacy, and the capacity for innovative activity. Their value lies in offering not a fragmented but a systemic model of physics teacher formation, in which scientific rigor, methodological soundness, and practical orientation function not as separate components but as interrelated elements of professional competence.

A final, yet fundamentally important, line of innovation within the Prykarpattia School was its orientation toward systematicity and the integration of knowledge, particularly through generalizing lessons in the school physics curriculum on the topics of "The Electromagnetic Field" and "The Contemporary Scientific Worldview", where emphasis was placed on the interrelationship of fundamental concepts and principles [2]. Such instruction ensured the formation of a holistic worldview and an understanding of physics as a system rather than as a collection of disconnected topics. In the contemporary context, these ideas are manifested in integrated science courses and STEM education, where knowledge from physics, mathematics, computer science, and technology is combined within project-based tasks. The use of artificial intelligence can further strengthen this integrative effect by supporting interdisciplinary projects, from consultations on the scientific and historical context of discoveries (thus implementing the principle of historicism) to assistance in modeling processes through programming and data analysis, thereby making the systematic nature of knowledge practically tangible for the learner.

Conclusions. Thus, the methodological innovations of the Prykarpattia School of Physics constitute a significant layer of Ukrainian pedagogical thought that demonstrates the continuity of ideas from the early forms of the technologization of instruction to the contemporary digital transformation of education. The generalization of experimental skills, technological feedback and assessment, the differentiation of learning activities, the fundamentalization of teacher training, and the integration of knowledge into a holistic picture of the world form a conceptual core consonant with the competence-based paradigm of the New Ukrainian School. The reinterpretation of these approaches within the framework of digital platforms and artificial intelligence opens up possibilities for transitioning from "programmed assessment" to personalized learning trajectories, for developing high-tech STEM environments grounded in the laboratory method, and for ensuring high-quality distance education through virtual experimentation and learning analytics. Reflection on and adaptation of this experience are important preconditions for shaping a competitive system of physics education in Ukraine that combines national methodological traditions with openness to global innovations.

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