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## On pre-service STEM teachers' training in Ukraine\*

**Abstract.** The paper reports on the aims, tasks, approaches, principles, content, forms, and methodological training of prospective teachers of physics, mathematics, and computer science at H. S. Skovoroda Kharkiv National Pedagogical University. It shows that methodological training of teachers provides a synthesis of subject matter, and psychological, pedagogical, and methodological skills.

In Ukraine, the training of prospective teachers is designed to meet public needs established in educational standards. In this context, methodological training is the main objective of professional pedagogical education.

A variety of research dedicated to methodological training of prospective teachers includes Atamanchuk P., Bugaev O., Goncharenko S., Korshak E., Martynyuk M., Lyashenko O., Sergeev O., Trifonova O., Trifonova V. Sharko.

Refinement of physical experiments using IT technologies is covered in S. Velychko, B. Myrhorodsky, V. Sumsy, V. Tyschuk.

Ukrainian scientists such as N. Burynska, V. Razumovsky, N. Talaluyeva and P. Fedoseev deal with the problems of integration in the natural sciences. O. Bugayov, S. Goncharenko, O. Ivanov, E. Korshak and O. Lyashenko made a significant contribution to the methodology of teaching of prospect physics teachers. A. Verbytsky, I. Korobova, and V. Sharko deal with the training teachers of physics. A. Voloshyna, M. Golovko, V. Matsyuk, O. Shkoly, M. Shut develop a historical approach to the education of physics.

The methodological competence of prospective teachers of mathematics is studied in I. Akulenko, N. Gluzman, O. Matyash, V. Motorina, E. Nelina, S. Skvortsova, N. Tarasenkova. N. Gluzman, O. Zhernovnikova, V. Motorina, A. Kuzminsky, N. Tarasenkova, O. Matyash, S. Skvortsova. A. Voevoda, O. Martynenko, I. Shyshenko, V. Chkan, E. Nelina, T. Richter, Y. Prostakova.

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Theoretical and practical aspects of methodological training of future teachers in computer science are covered in studies by N. Balyk, L. Bilousova, V. Lapinsky, M. Zhaldak, N. Morse, S. Semerikov, Y. Ramsky, O. Spivakovsky, Y. Trius, V. Bespalko, O. Zair-Bek, O. Prykot, V. Radionov, V. Slobodchikov, Y. Tyagunov, V. Bykov, S. Ovcharov, V. Radul, O. Spirin, Yu. Horoshko, Z. Seidametova, N. Olefirenko, V. Osadchy, N. Ponomareva, S. Priyma, S. Rakov, I. Teplytsky and others.

The article aims to reveal the principles of methodological training of future teachers of physics, mathematics, computer science at H.S. Skovoroda Kharkiv National Pedagogical University.

Methodological training provides a synthesis of subject matter and psychological, and pedagogical skills. The principles of that training include: consistency, continuity, and systematicity; scientificity and relevance (knowledge and professional skills); connection of theory with practice; consciousness, activity, and independence; axiology, integration, predictability, innovation, and reliance on their own practical experience.

Methodological training of teachers in computer science takes into account the importance of ensuring the advanced nature of the study through the following features:

- the constant updating of the recommended theoretical material, the instantaneous obsolescence of textbooks,
- the readiness to work in the context of updating the technical support of computer science training related to the development of information technology and constant changes in computer technology, from desktop personal computers to laptops, tablets and smartphones, changes in software used;
- the need to introduce the latest educational technologies and latest forms and methods of educational activities related to information and communication technologies – STEAM projects, distance learning, blended and mobile learning technologies, the use of electronic educational resources;
- ensuring readiness to work with the new digital generation of students (reducing the age of the first acquaintance with the computer, the formation of new personality traits of the digital generation, digital inequalities of students and teachers, etc.);
- compensatory nature of the organization of the educational process, taking into account the different levels of initial training of students.

Student-oriented technology for building methodological training for future computer science teachers supposes their involvement in projects on individual topics and helps to reveal their potential. For example, students are involved into:

- activities on career guidance work with students (training, mini-master classes, interactive demonstrations, etc.);
- conducting master classes and group classes in Computer Science with students;
- conducting extracurricular activities for students on the basis of the department;
- preparation and holding of city tournaments in Computer Science for students of 5–7 grades, all-Ukrainian tournament in Computer Science for students of 9–11 grades;

– preparation and holding of the an all-Ukrainian Olympiad in Computer Science, etc.

The specifics of the Faculty of Physics and Mathematics is that the methodological training of future teachers in the specialties of the faculty should ensure the formation of skills in methodically and technically correct formulation and performance of demonstration experiments in particular in Physics, including laboratory workshops, skills in using physical devices etc.

It should be noted that the Department of Physics has developed the concept of combining demonstration and laboratory experiments with elements of modern measuring technologies based on the use of digital technologies, resulting in the creation of an automated computer system “Experimenter”. All laboratories of the Department are provided with guidelines for laboratory work, which provides basic theoretical material, methods of research of physical phenomena and laws, description of experimental installation or devices, procedure for processing measurement results and control questions.

Teachers of the Department are constantly modernizing and expanding both the material and methodological base for teaching future teachers how to conduct a training demonstration experiment.

In response to the challenges of distance learning at the Department of Physics, first of all, the training of future teachers to organize video recordings of real physical experiments and methods of their use in synchronous and asynchronous broadcasting is introduced. Secondly, it prepares students to conduct virtual and model experiments (online or prepared in advance) in special services. Thirdly, a remote access experiment was organized to boost software and hardware complexes in physics in real-time, with the measurement of parameters followed by a discussion.

All materials developed during the study replenish the stakes of physical Internet demonstrations (its formation with the participation of higher education students began in 2020 in the context of the emergency implementation of distance learning through the COVID-19 pandemic), which is open to all students for further use during the lessons and further during pedagogical practice.

Pedagogical practice in general and specialized secondary education institutions is an integral part of the educational process of teacher training at the Faculty of Physics and Mathematics. The Regulations and the Program of Pedagogical Practices have been developed and regularly reviewed at the Departments by the current requirements.

The Bachelor’s curriculum provides continuous pedagogical practice in schools and health and recreation camps for children. Pedagogical practice in institutions of specialized secondary education and research practice is provided for the Master’s level.

It should be noted that the leaders of pedagogical practices at the Faculty of Physics and Mathematics are highly qualified teachers with experience in teaching at school. In general, 50% of teachers of the Department of Mathematics, 75% of teachers of the Department of Physics and 100% of teachers of the Department of Computer Science have experience of their own pedagogical activity in general education institutions.

In 2021, the Faculty of Physics and Mathematics introduced an educational program “Educology“ for applicants for the second (Master’s) level of higher education in the specialty 011 Educational, Pedagogical Sciences (Zelenska et al., 2022). Considering the purpose, the program results of the educational program also provide for the implementation of methodological training of applicants, primarily in the process of mastering the normative educational components (“Productive Pedagogy and Teaching Methods of Pedagogical Disciplines“, “Digital Didactics“, “Supervision and Coaching in Education“), as well as due to the block of disciplines of free choice “Pedagogical Skills of the Teacher“. In particular, the content of each lesson on the subject “Productive Pedagogy and Methods of Teaching Pedagogical Disciplines“ (training cycle) includes issues that provide insights into innovative pedagogical ideas, provisions, concepts, opportunities for their implementation in educational practice of general secondary, professional and high school. Within the framework of scientific and pedagogical practice, students are expected to perform methodical work of teachers, such as: development of a syllabus of fragments of lectures, seminars / practical classes, preparation of their didactic support using modern innovative pedagogical technologies (presentations, test tasks for lectures; tasks for independent work on the discipline). During the internship, applicants are supposed to master the method of assessing educational and management processes, the internal quality assurance system of general secondary education in the process of institutional audit, the method of expert assessment of professional competencies of certification participants by studying their practical experience.

Applicants for higher pedagogical education at the Faculty of Physics and Mathematics are highly motivated to professional methodological growth. For example, in the last two years, the best teachers-practitioners, leading methodologists, heads of educational institutions of Ukraine are actively invited to meetings with future teachers. Student scientific-methodical conference “Naumov readings“ is held annually, a separate section of it is devoted to the Methods of Teaching Physics, Mathematics and Computer Science. The conference of young scientists “Innovative Pedagogical Technologies in Digital School“ is annual too. The topics of all Master’s researches (without any exceptions) are devoted to selected issues of Methodology and their implementation in the educational process in educational institutions.

Thus, the analysis of the concept of methodological training of teachers of physics, mathematics, and computer science at the Faculty of Physics and Mathematics of H.S. Skovoroda Kharkiv National Pedagogical University confirms that methodological training of future teachers is cross-cutting, carried out during the entire period of their education and consists of integrating subject, general psychological, pedagogical, methodological knowledge, and experience of their practical activities in the specialty. Implementation of the developed concept of methodical training of future teachers allows to provide preconditions for the creation of a trajectory of their further professional development focused on their personal and professional growth, and successful professional self-realization. Promising areas of further research is the establishment of experimental verification of the effectiveness of the system in the context of professional training of future teachers.

## References

- The concept of development of pedagogical education*: 2018. Accessible at: <https://mon.gov.ua/ua/npa/pro-zatverdzhennya-koncepciyi-ozvitku-pedagogichnoyi-osviti>
- Malets, E.: 2021, *Educational and professional program "Physics in Educational Institutions". The first (Bachelor's) level of Higher Education*. H.S. Skovoroda KhNPU, Kharkiv. Accessible at: [http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96\\_programi/Osvitni\\_programu\\_bakalavr/2021\\_rik/Fizika\\_v\\_zakladakh\\_osviti.pdf](http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96_programi/Osvitni_programu_bakalavr/2021_rik/Fizika_v_zakladakh_osviti.pdf).
- Zhernovnykova, O., Deinichenko, T., Vodolazhenko, O., Shytkova, L., Shevchenko, M.: 2021, *Educational and professional program "Mathematics in Educational Institutions". The first (Bachelor's) level of Higher Education*. H.S. Skovoroda KhNPU, Kharkiv. Accessible at: [http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96\\_programi/Osvitni\\_programu\\_bakalavr/2021\\_rik/Matematika\\_v\\_zakladakh\\_osviti.pdf](http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96_programi/Osvitni_programu_bakalavr/2021_rik/Matematika_v_zakladakh_osviti.pdf).
- Ponomarova, N., Olefirenko, N., Andrievska, V., Ostapenko, L., Diakova, I., Hrebeshkova, A.: 2021, *Educational and professional program "Computer Science in educational institutions". The first (Bachelor's) level of higher education*. H.S. Skovoroda KhNPU, Kharkiv. Accessible at: [http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96\\_programi/Osvitni\\_programu\\_bakalavr/2021\\_rik/%D0%86nformatika\\_v\\_zakladakh\\_osv%D1%96ti.pdf](http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96_programi/Osvitni_programu_bakalavr/2021_rik/%D0%86nformatika_v_zakladakh_osv%D1%96ti.pdf)
- Malets, E.: 2021, *Educational and professional program "Physics in Educational Institutions". The second (Master's) level of Higher Education*. H.S. Skovoroda KhNPU, Kharkiv. Accessible at: [http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96\\_programi/Osvitni\\_programu\\_magistr/2021\\_rik/Fizika\\_v\\_zakladakh\\_osviti.pdf](http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96_programi/Osvitni_programu_magistr/2021_rik/Fizika_v_zakladakh_osviti.pdf).
- Nelin, E., Zhernovnykova, O., Deinichenko, T., Yeremenko Yu., Tsys, Ya.: 2021, *Educational and professional program "Mathematics in Educational Institutions". The second (Master's) level of Higher Education*. H.S. Skovoroda KhNPU, Kharkiv. Accessible at: [http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96\\_programi/Osvitni\\_programu\\_magistr/2021\\_rik/Matematika\\_v\\_zakladakh\\_osviti.pdf](http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96_programi/Osvitni_programu_magistr/2021_rik/Matematika_v_zakladakh_osviti.pdf).
- Olefirenko, N., Ponomarova, N., Andrievska, V., Ostapenko, L., Diakova, I., Denysova, H.: 2021, *Educational and professional program "Computer Science in Educational Institutions". The second (Master's) level of Higher Education*. H.S. Skovoroda KhNPU, Kharkiv. Accessible at: [http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96\\_programi/Osvitni\\_programu\\_magistr/2021\\_rik/Informatika\\_v\\_zakladakh\\_osviti.pdf](http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96_programi/Osvitni_programu_magistr/2021_rik/Informatika_v_zakladakh_osviti.pdf).
- Zelenska, L.: *Educational and professional program "Educology". The second (Master's) level of Higher Education*. H.S. Skovoroda KhNPU, Kharkiv. Accessible at: [http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96\\_programi/Osvitni\\_programu\\_magistr/2021\\_rik/Osvitologiya.pdf](http://smc.hnpu.edu.ua/files/Osv%D1%96tn%D1%96_programi/Osvitni_programu_magistr/2021_rik/Osvitologiya.pdf).

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