DOI:10.59787/2413-5488-2025-49-1-37-51

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THE ROLE OF PHYSICAL PRACTICAL COURSE IN IMPROVING RESEARCH SKILLS OF FUTURE TEACHERS

Abstract: The article separately reveals the main components of a special physical workshop. It discusses the theoretical support of the workshop and a set of laboratory works related directly to the research work, and analyzes their main goals. The level of scientific research competencies "before and after" of the controlled groups is compared using research methods, including surveys.

Based on the physics workshop, it will be shown what impact the presentation of educational and teaching aids has on the formation of scientific and research competencies of future physics teachers, as well as the innovation of these tools and the positive impact they have on the teacher and student. In addition, by analyzing the place of methodological recommendations and applications in the educational process, he offers the advantages of a logical continuation of his independent scientific and design work. A selection of the results of the analysis with a comprehensive study of the current topic is demonstrated. Considering the purpose and main objectives of the proposed physics workshop to solve the problem, its influence on the student and the importance of his place in solving the problem are proven. The importance of the main components of knowledge, skills and abilities in performing laboratory work does not lag behind. Thus, the need to provide educational and teaching aids for physics workshops is proven. That is, it shows what role the course plays and reveals its relevance. The result is a positive growth of 42%.

Key words: physics teacher, physics workshop, laboratory work, research competence.

Introduction

The main component of the development of methodological foundations for the formation of scientific research competencies of future physics teachers is a physics workshop. The main goal of the physics workshop is to develop the scientific research competencies of future physics teachers using the example of X-ray diffraction. This aligns with research findings emphasizing the role of practical coursework in fostering research skills among teachers (Plotskaja et al., 2023; Kurbanbekov et al., 2018).

Considering physics teachers in a general sense, they are professionals with developed skills of comprehensive critical thinking, who are fully proficient in the educational methodological complex and have research competencies, since physics is a fundamental science. The necessity of such competencies has been highlighted in various studies, particularly in relation to improving assessment literacy among teachers in Kazakhstan (Shmigirilova et al., 2022; Testov & Perminov, 2023).

The special course is called "X-ray diffraction." The main goal of the course is to become an integral part of the methodology and formation of research competencies of bachelor students and master's degree students of the educational program "Physics," i.e., future physics teachers. This approach is comparable to methodologies employed in developing functional competencies in STEM education (Jeonga et al., 2019; Zanabazar et al., 2023). A special elective course is studied by future physics teachers, specifically 4th-year undergraduate students and 2nd-year master's degree students. Physics workshops consist of educational and teaching aids, which play a crucial role in strengthening research skills (Mok et al., 2023).

The manual was written to cover the theoretical part of the physics workshop. That is, we can say that the main lectures of the workshop have been compiled. It is important to note that this will serve as a continuation of the tutorial, ensuring the application of theoretical knowledge in laboratory and research activities. Similar methodologies have been successfully applied in STEM education, demonstrating the effectiveness of hands-on experience in enhancing research capabilities (Tang & Zi, 2023; Shumeiko et al., 2024).

The educational manual is based on several laboratory works, aimed primarily at diffraction analysis of X-rays. Laboratory work will help future physics teachers develop scientific research competencies and effectively use the acquired knowledge and skills in the future. Moreover, each laboratory work is complemented by control questions to reinforce understanding. The use of advanced equipment such as the X-ray diffractometer aligns with contemporary approaches to physics education, ensuring students engage with complex scientific methodologies (Kabanova, 2023).

This approach is in line with the findings of "The Role of Physical Practical Course in Improving Research Skills of Future Teachers," which emphasize the importance of integrating research-based coursework into teacher training programs. The development of such competencies is crucial for ensuring that physics teachers can not only convey fundamental concepts but also engage in scientific inquiry and innovation in their professional activities.

The main goal of the article is to prove the need to provide educational and teaching aids for physics workshops. That is, to show what role the course plays and reveal its relevance. This:

1. Prove in the form of a pedagogical expert the influence of a physics workshop on the formation of scientific research competencies of future physics teachers.
2. Show the positive impact of the proposed innovations on improving research skills.

The textbook is called "Theoretical Fundamentals of X-Ray Diffraction" (Skakov & Dalabayev, 2024). As an innovation, several types of tasks are offered. For example, research paper topics for independent work. This section presents topics of research work aimed at developing the scientific research competencies of future physics teachers (Skakov, Dalabayev, Choruh, & Nurizinova, 2024). At what level students receive the knowledge gained from the physics workshop and the skills they develop, topics are offered as the main final material of this workshop. We expect that research topics will be successfully defended with the help of high-quality knowledge obtained from the workshop (Skakov & Dalabayev, 2024).

We will also write a short guide to the proposed extensive topic. That is, students understand how to develop a topic by mastering special instructions (Skakov & Dalabayev, 2024). Thus, the scientific research competencies of future physics teachers will develop, which will allow them to be used in the future in other topics in the field of physics (Litvinov & Gorelik, 2024).

The textbook presents the theoretical foundations of x-ray diffraction in higher education institutions. Here, theoretical information on the topic is transmitted together with control questions. As a continuation of this manual, a set of laboratory work is proposed in the form of a teaching aid. In addition, this work provides special tasks to consolidate the topic under consideration. These tasks are intended to develop students' scientific research competencies (Alimbekova, 2020). Problems and information were developed under the guidance of STEM technology and other modern methods were used effectively (Kasymova, 2019). Developmental tasks help improve the student's critical thinking. The work is competently written in academic language, fully reveals its topic, and contains the most necessary information (Generalova, 2021).

The textbook is intended for university teachers, young professionals, as well as for students and master’s degree students studying in a special course “X-ray diffraction”.

The materials and methods of the study

The main research method used is observation, interviews, surveys, questionnaires, testing, photography, counting, measurement, comparison.

Scientific examinations bachelor department of the East Kazakhstan University named after Sarsen Amanzholov 6B015 training of natural science teachers, including B010 training of physics teachers, students of the educational program 6B01502 Physics.

Master's degree students of the educational program 7M01502 Physics for the training of teachers in natural science disciplines 7M015 of the master's department of this educational institution, including the training of physics teachers M011, were also involved. Also, the bachelor department of Khoja Akhmet Yassawi International Kazakh-Turkish University 6B015 training of natural science teachers, including B010 training of physics teachers. Students of the educational program 6B01520-Physics and master's degree students of the educational program 7M015 in natural science subjects of the master's degree, including training of physics teachers M011 master's students of the educational program 7M01520 Physics, were taken under control. (Table 1-A and 1-B) The surveys are shown in the figure below:

Table 1-A

Survey for students and master’s degree students

Survey for Students and Master's Students Dear student! Please provide complete answers to the questions below.		
No	Question	Answer
1	Provide the definition of the phenomenon of diffraction:	
2	What is the difference between geometric optics and wave optics?	
3	Are you familiar with the concept of X-ray diffraction?	1 - Yes 2 - No 3 - I forgot. If you are familiar with it, please provide the definition:
4	Please present the formula based on Bragg-Wulf theory:	1-2dsinθ=nλ 2-5dsinθ=2λ 3- I find it difficult to answer
5	In what year did Conrad Röntgen discover the properties of X-rays?	1-1900 2-1895 3-1850
6	Is it necessary to develop the methodological foundations for forming research competencies of future physics teachers using the phenomenon of diffraction as an example?	1-necessary 2-not necessary 3- I find it difficult to answer If necessary, why?
7	Have you been to the National Scientific Laboratory for Collective Use?	1- yes 2-no 3- I have no information about the laboratory if you are, for what purpose
8	Are you familiar with the X-ray diffractometer equipment at the national scientific research laboratory for collective use based at Sarsen Amanzholov East Kazakhstan University?	1-yes 2-no 3- I find it difficult to answer "If you are familiar, could you please describe the structure and working principle of the X-ray diffractometer?"
9	Are you engaged in scientific research activities?	1-I am currently engaged in it. 2-I have not been involved in scientific research activities. 3-There is no demand for scientific research activities. Why have you not been involved in scientific research activities?

10	Did you encounter any known or unknown difficulties during your involvement in scientific research activities?	1- Yes, difficulties arose 2- No, difficulties did not arise. 3- I find it difficult to answer If difficulties arose, what difficulties did you encounter?
Thank you for taking the time to respond to the survey!		
Holder of the State Prize of the Republic of Kazakhstan in the field of science and technology named after Al-Farabi, Doctor of Physico-mathematical Sciences, Professor, Academician of Kazakhstan National Academy of Natural Sciences, Professor of the Department of Physics and Technology at "Sarsen Amanzholov East Kazakhstan University.		Skakov M.K. __________ (sign)
PhD student of the 1st year of the educational program 8D01502 – "Physics."		Dalabayev T.N. __________ (sign)

Table 1-B

Survey for university teachers

For University Teachers SURVEY "Dear Colleague! We kindly ask you to provide complete answers to the questions presented below."						
Teacher's full name:.. Total number of students: .... of which the number of groups in the Physics major: .... Please assess how well the skills listed below have been developed in your students using a five-point scale. We kindly ask you to place a '+' sign in the appropriate column.						
No.	Assessable Research Competency	1	2	3	4	5
1	Collection and Systematic Analysis of Scientific Data					
2	Ability to Make Preliminary Hypotheses					
3	Setting Personal Goals for the Research Topic					
4	Defining the Objectives of the Research Work					
5	Defining the Subject and Object of the Research					
6	Ability to Present One's Perspective					
7	Applying Observation or Other Research Methods					
8	Implementing or Organizing the Research Work					
9	Analyzing the Results of Scientific Research Work					
10	Documenting and Presenting the Results of Scientific Research Work According to Requirements					
Holder of the State Prize of the Republic of Kazakhstan in the field of science and technology named after Al-Farabi, Doctor of Physico-mathematical Sciences, Professor, Academician of Kazakhstan National Academy of Natural Sciences, Professor of the Department of Physics and Technology at "Sarsen Amanzholov East Kazakhstan University.			Skakov M.K. __________ (sign)			
PhD student of the 1st year of the educational program 8D01502 – "Physics."			Dalabayev T.N. __________ (sign)			
Thank you for taking the time to respond to the survey!						

In order to systematically conduct research work, we divided the supervised students and master's degree students into groups A, B, C, D. To determine the effectiveness of the surveys and physical workshops, depending on the main research plan of the groups, we classified the proposed educational and teaching aids into parts A and B, C and D, depending on assimilation. (Table 2) Information about the groups monitored is presented in the table below:

Table 2
Information about participants

№ Group number	Group educational program code	Name of the group during the pedagogical experiment	Number of students in the group
1	7M01502	A	12
2	6B01502	B	8
3	6B01502	B	15
4	6B01520	C	20
5	6B01520	C	13
6	7M01520	D	22
Total number of participating groups: 6			Total number of students 90

There are 6 groups participate in the pedagogical experiment. Three groups will be the control group. That is, let's designate the groups participating in the experiment as A, B, C, D. Groups A and B will be the primary control groups. They are limited only to mastering the textbook and completing tasks of the same work. And groups C and D completely complete physical workshop.

The main goal is to compare changes “before and after” in the development of research competencies among future physics teachers with a comparison of groups.

Table 3
Comparison table

Completed work	Group A and B	Group C and D
Mastering the theoretical sections of the textbook	+	+
Physical dictation	+	+
Word cloud	+	+
Make up the formula	+	+
Physical puzzle	+	+
Developing the set of laboratory works of the educational and methodological manual	-	+
Laboratory work № 1	-	+
Laboratory work № 2	-	+
Laboratory work № 3	-	+

The table above (Table 3) shows the mastered sections of the primary groups A, B and control groups C, D, depending on the proposed methodological foundations.

The key distinction between the experimental groups lies in the scope and depth of their engagement with research activities. Groups A and B primarily focused on mastering theoretical sections of the textbook and completing structured exercises such as physical dictation, word clouds, formula creation, and physical puzzles. In contrast, Groups C and D engaged in a more comprehensive approach, integrating hands-on experimental work through the development of laboratory activities outlined in the educational and methodological manual.

Additionally, while all groups covered core theoretical material, only Groups C and D participated in laboratory experiments (Lab Work №1, №2, and №3), allowing them to apply theoretical knowledge in practical settings. This hands-on experience aimed to enhance their research competencies beyond passive learning.

By comparing the "before and after" results across these groups, the study evaluates how direct participation in physical workshops influences the development of research skills among future physics teachers. The inclusion of laboratory tasks in Groups C and D is expected to provide a deeper understanding of scientific concepts and foster stronger investigative abilities compared to the control groups (A and B).

Although the vast majority of topics presented in the textbook, which is the main component of the physics workshop, are areas of scientific physics, changes and additions are allowed in order to direct these topics into a scientific and pedagogical direction.

Research skills are an essential component of the professional training of future physics teachers, as they contribute to the development of critical thinking, analytical abilities, and problem-solving competencies. In the context of physics education, research skills encompass the ability to formulate scientific questions, design and conduct experiments, analyze and interpret data, and effectively communicate findings.

Key components of research skills:

- Formulation of research questions – The ability to identify relevant scientific problems, formulate hypotheses, and structure research objectives. This skill is fundamental for engaging in meaningful scientific inquiry.
- Experimental design and implementation – The competence to develop and carry out experiments using appropriate methodologies, tools, and techniques. This includes working with laboratory equipment such as X-ray diffractometers, which play a crucial role in solid-state physics research.
- Data collection and analysis – The ability to systematically collect, process, and interpret experimental data using statistical and computational methods. Proper analysis is crucial in verifying hypotheses and drawing scientifically valid conclusions.
- Scientific communication – The capacity to present research findings in written and oral formats, including writing research papers, reports, and presentations. This skill is essential for participation in scientific discussions and the dissemination of knowledge.
- Critical thinking and problem-solving – The ability to critically evaluate existing scientific literature, identify gaps in knowledge, and propose innovative solutions to scientific challenges.

Evaluation criteria for research skills:

To assess the research competencies of future physics teachers, a set of objective evaluation criteria has been established. These criteria ensure a structured approach to measuring students' progress and capabilities in conducting scientific research.

1) Clarity and relevance of research questions – the extent to which students can define a research problem and formulate clear, logical, and scientifically relevant hypotheses.
2) Experimental proficiency – the ability to conduct experiments independently, demonstrating proficiency in handling laboratory instruments, following safety protocols, and applying appropriate research methods.
3) Data interpretation and analytical skills – the accuracy and depth of data analysis, including the use of appropriate mathematical models and software for data processing.
4) Scientific writing and presentation – the effectiveness of presenting research results in a well-structured, coherent, and scientifically rigorous manner, following academic writing standards such as APA format.
5) Originality and innovation – the ability to propose creative and original solutions to research problems, contributing new insights to the field of physics education.
6) Collaboration and adaptability – the capability to work effectively in research teams, engage in academic discussions, and adapt to new scientific challenges.

By integrating these research skills into the physics practical course, future teachers not only gain a deeper understanding of fundamental physics concepts but also develop the competencies necessary for lifelong learning and scientific inquiry. The implementation of these criteria ensures that students are adequately prepared for academic and professional challenges in physics education and research.

For example, Topic No. 1 “X-ray diffraction analysis and study of the strength properties of copper”, Topic No. 2 “X-ray diffraction analysis and study of the strength properties of aluminum”, Topic No. 3 “examples of encounters with the phenomenon of diffraction at home in secondary schools and independent laboratory work at home conditions." Then, first of all, students master the theoretical textbook of the workshop.

The textbook consists of an introduction, conclusion, list of references, and 10 sections. Main topics include the physics of X-rays, discovery of the concept of X-rays, the electromagnetic spectrum, characteristics of radiation, refraction of X-rays, scattering of X-rays, and fluorescent radiation. Additionally, it covers the basics of X-ray diffraction, the general diffraction phenomenon, X-ray diffraction, the crystal structure of solids, crystal lattices, Bravais lattices, and nodal rows in a crystal lattice. The textbook also discusses X-ray grating diffractometers, goniometers, types of focusing, types of X-ray diffractometers, including DRON and X PERT PRO models, intensity factors, atomic scattering function, interference analysis function, ray scattering of atomic groups, influence of the temperature factor, X-ray diffraction patterns, and X-ray diffraction analysis of copper (Cu) and aluminum (Al).

To enhance the learning experience, the textbook provides research topics for independent work, a set of theoretical problems, and various engaging activities such as physical dictation, word cloud, "Make up a formula," and physical puzzles. The inclusion of these tasks is aimed at improving students’ research competencies by integrating modern approaches to physics education (Skakov & Dalabayev, 2024; Litvinov et al., 2021; Generalova, 2021). The methodology is aligned with contemporary educational standards, incorporating STEM-based learning principles and case-based instruction to foster a deeper understanding of the subject (Alimbekova, 2020; Kasymova, 2019).

Thus, having mastered the theoretical material and fully answered the control questions, students begin to complete developmental tasks for the formation and development of scientific research competencies. It should be noted that even through the quality of these tasks, the teacher can assess the quality of mastering the theory. Next, a set of theoretical tasks.

In other words, the above examples of tasks will be presented in the tutorial. All the groups that participated in the research work fully assimilated the proposed textbook, which is the main component of the physics workshop. In turn, the textbook received certificate No. 42606 “On entering information into the State Register of Copyrighted Objects”.

Thus, after all the controlled groups have mastered the whole-blooded textbook, the second stage of research work begins. Now half of the supervised groups will limit themselves to the first stage, and the other half will begin to master the proposed educational and methodological manual in order to fully master the physical workshop.

Results and discussions

After studying a physics workshop, students will develop a desire for research activities, and develop research competencies that have been developed over the years. The textbook, called Theoretical Fundamentals of X-Ray Diffraction, complements the main theoretical basis of the workshop, that is, it can be considered a set of lectures. And this teaching aid can be considered a continuation of the above-mentioned teaching aid.

The teaching aid is based on the textbook “Theoretical Fundamentals of X-Ray Diffraction”. That is, it can be considered as a continuation of the textbook. The textbook “Theoretical Fundamentals of X-Ray Diffraction”, dedicated to the special course “X-Ray Diffraction”, is supplemented in the form of lectures, then There is a theoretical approach, this educational manual presents laboratory work and methodological applications for the practical application of the acquired theoretical knowledge.

Test questions cover laboratory work aimed at conducting X-ray diffraction analysis, formation and development of scientific research competencies of future physics teachers. In this case, the criteria for assessing laboratory work are provided to help the teacher. An innovation has been introduced in maintaining a student development schedule. New ideas on modern topics were also written using assessment sheets, interesting ways to conduct laboratory work, and writing conclusions for laboratory work.

The educational and methodological manual is recommended for use by students of master’s and bachelor degree of the educational program "Physics", studying in a special elective course "Theoretical Foundations of X-ray Diffraction", as well as university teachers and young specialists.

The educational manual consists of an introduction, a conclusion, a list of references and 9 sections. Main sections: laboratory work № 1, familiarization with the principle of operation of an X-ray diffractometer, laboratory work № 2, conducting X-ray diffraction analysis of aluminum, laboratory work № 3, determining the second unknown with diffraction analysis of copper, topics of scientific research projects (as a continuation of scientific research work) , criteria for evaluating laboratory work, student progress chart, Evaluation sheet, Writing a conclusion for laboratory work, Interesting ways to conduct laboratory work.

In this section of the textbook, you will be presented with topics for research projects. Students begin to study these topics after completing the workshop, using the research competencies gained and developed from this physics workshop. Then these topics will become a continuation of the development of methodological foundations for the formation of research competencies of future physics teachers. The topics presented to you are divided into scientific-pedagogical and pedagogical. Because this workshop will study the main specialties of the educational program in physics. Topics can be used by students in combination with the topics of the thesis and master's dissertation.

That is, this will be an advantage of the proposed physics workshop. Because after completing the workshop, students do not stop and continue it as independent work. Let's take the following topics as an example.

“This, (scientific and pedagogical direction)” is the implementation, with the help of research bases, of independent scientific research work of students of the physics program at universities, “(scientific direction)” generalization of the results of X-ray diffraction analysis of cobalt.”

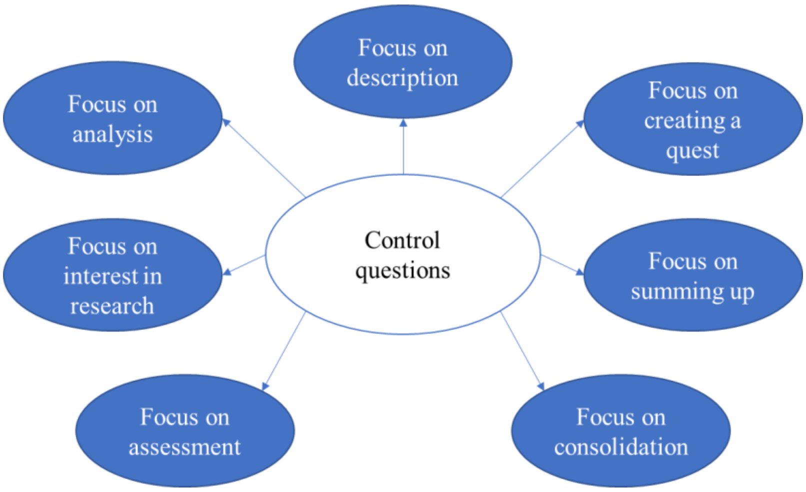
The main goal in the educational process is to assess the achievements of a student. Therefore, it is currently becoming relevant to provide special assessment criteria on the topic. If we determine through the tasks how well we have received knowledge on the topic we have passed, special criteria should also be proposed for these tasks. Advantages of presenting the assessment criteria:

- clarity of the learning process,
- high-quality feedback between students and teachers,
- based on the criteria, students understand their level from the inside,
- optimization of the evaluation process.

Test questions are questions that help determine how comprehensively a student has understood a lab before summarizing the lab and lead to the student's search and opinion being organized. Before answering a question, the student must be fully familiar with the lab's progress and complete the objective of the lab. When answering test questions, it is best to provide evidence for each question from the point of view of physical science. The teacher may also ask additional clarifying questions.

Test questions are based on the directions shown in Figure 1. Each direction corresponds to one separate point. That is, test questions are focused primarily on assessment, and then on consolidating the topic, summing up, searching, describing a specific physical phenomenon, attracting the student to study, and analyzing the topic.

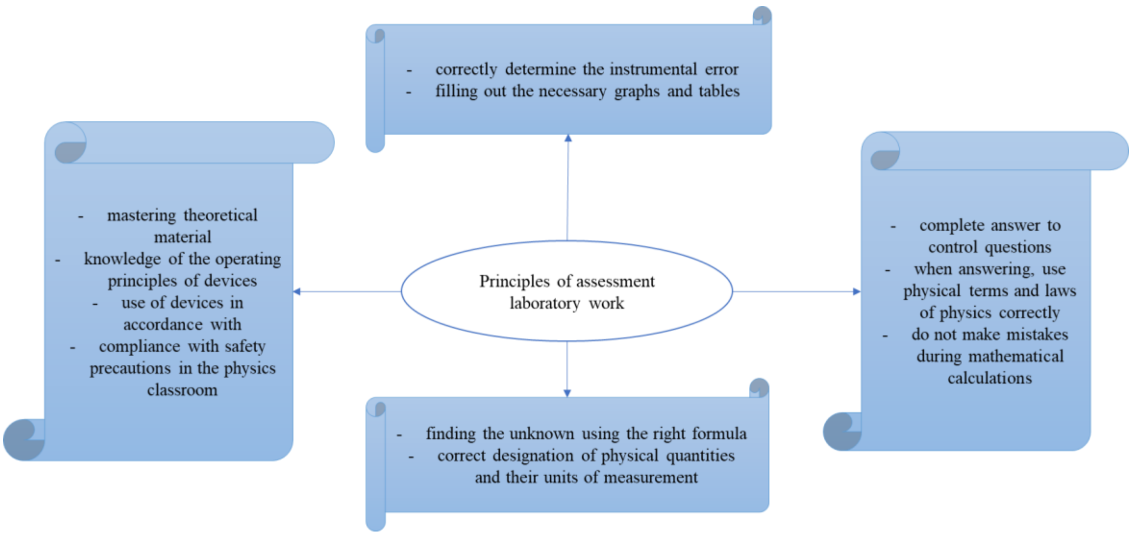
Figure 1
Directions of test questions



When assessing laboratory work, special attention should be paid to the student's level of knowledge of theory, knowledge of the direction and operation of equipment, and high-quality answers to test questions. Each of them, in turn, is assessed on the basis of clear rules, such as correctly stating and proving physical laws and rules, creating the following formula using the necessary formulas.

Traditionally, we know that the assessment format includes mainly the generalized skills required. Therefore, when evaluating laboratory work, it is necessary to diverge from traditional evaluation and adhere to the basic principles outlined in the figure below. This is shown in Figure 2.

Figure 2
Principles of assessment



Considering that assessment work is the most important component of the educational process, it can be understood that this greatly helps the teacher and the student. This is because the effective evaluation of each laboratory work affects the effectiveness of the research work.

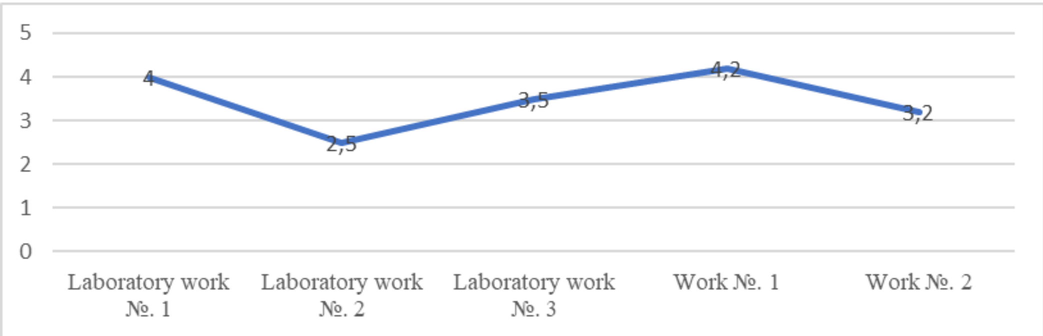
Based on the assessment principles presented above and the assessment criteria for the topic, we recommend writing a clearly violated principle on this assessment sheet. The assessment sheet is shown in the following Figure 3.

Figure 3
Assessment sheet

discipline: "Physics"	Laboratory work №. 1	Topic:
Date:	Group:	Student:
№	Principles of assessment:	Assessment:
Warning:	Violated principle:	Ways to fix:

That is, if students completed 4 laboratory works, then 4 such assessment sheets will be completed for each of them. The student's progress is then graphed as shown below. This is shown in the following Figure 4.

Figure 4
Student progress graph



In this way, all these applications will systematically fix the problem at hand and point the way to the next step. It is an indispensable addition that creates a relationship between teacher and student.

The knowledge progress graph is an application that is an indispensable assistant to the teacher, showing how well all laboratory work has been completed as a whole and how well the knowledge has been acquired by those who completed it. Not only for the teacher, but also for the student. This is because by looking at the score chart, you can find out which labs have errors and which labs performed poorly and which performed well. Thus, one should come to a generalized conclusion and carry out additional work to correct the missing gap. Looking at the graph above, we can see the success of knowledge. First of all, help the teacher. This is because a graph can be used to present to the learner what should be repeated as feedback. Of course, this chart can be used for other purposes. The main thing is that all the work carried out produces results and becomes an integral part of the methodology for developing the research competencies of future physics teachers.

To use the above tasks, first of all, students get acquainted with the set of lectures in a special textbook presented for the workshop, and answer test questions at the end of these sections. Students who have theoretical knowledge begin to perform laboratory work, completing tasks in the process of developing scientific and research competencies.

For clarity of comparison and pedagogical experiment, we present below fragments of laboratory work in the complex of basic laboratory work. That is, a total of 3 laboratory works is offered. They are aimed at developing the scientific research competencies of future physics teachers using theoretical knowledge in practice. Below is a short excerpt from the labs presented to you!

1. Laboratory work №. 1

Topic: "Introduction to the operating principle of an X-ray diffractometer."

Work objective:

(Operator) familiarization with equipment for obtaining diffraction samples under the guidance of a research assistant, reading the operating principle of a diffractometer, mastering the choice of shooting conditions, techniques for manufacturing and installing samples, obtaining diffraction laws.

Equipment: X-ray diffractometer X’Pert PRO. Students will learn the operating principle of the above tool and the work of developing the model.

2. Laboratory work № 2

Topic: "Conducting X-ray diffraction analysis of aluminum."

Work objective:

(Operator) Obtaining a diffraction X-ray sample of aluminum under the supervision of a research assistant.

Equipment: X'Pert PRO X-ray diffractometer, aluminum model.

That is, according to the study, they should get a diffraction pattern below. Thus, in this laboratory work, students apply the acquired skills in practice.

3. laboratory work No. 3

Topic: "Determining the second unknown by performing diffraction analysis of copper."

Work objective:

(Operator) identification of an unknown element in a mixture by taking an X-ray diffraction sample of copper under the direction of a research assistant.

Equipment: X'Pert PRO X-ray diffractometer, copper sample (with impurity).

That is, according to the study, he should obtain the diffraction pattern below and detect an unknown substance.

Thus, in this laboratory work, students apply the acquired skills in practice and identify an unknown substance.

The main component of laboratory work is the conclusion.

The formulation of conclusions is a critical aspect of research work, reflecting the researcher's ability to analyze results and synthesize key findings. In the context of physics education, particularly in laboratory-based courses such as X-ray diffraction analysis, well-structured conclusions contribute to the development of students' research competencies. As noted in studies on research skill formation in future physics teachers, the ability to draw scientifically grounded conclusions is integral to their professional development (Shirina, 2019; Appendix 112, 2022; Evstifeev, 2017). This aligns with our approach in “The Role of Physical Practical Course in Improving Research Skills of Future Teachers,” where we emphasize hands-on experience and systematic reflection as key components of scientific competency formation.

- Direct communication with the purpose of laboratory work.

- Reveal your work.
- Coverage of achieved goals.
- Description of the progress in achieving the goal of the laboratory work.
- Show the reason for the occurrence of a physical phenomenon or pattern in the topic of laboratory work as a real phenomenon from a scientific point of view and in practice.
- Adding used basic tools and formulas as keywords and much more.

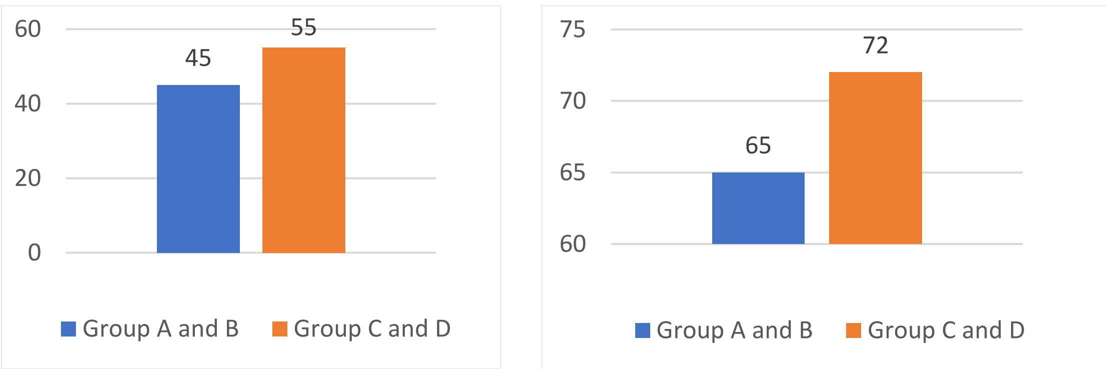
In order for the basic requirements to be met, the student must first fully complete and understand the laboratory work. Looking only at the conclusions, you can understand how correctly the student acted, how correctly he formulated the thought.

The requirements for all laboratory work are the same. They are:

- Availability of the purpose of laboratory work;
- Indicate the list of equipment used in the work;
- Drawing up a laboratory work plan;
- Presentation of theoretical data of laboratory work (brief and accurate data about the phenomenon or pattern under consideration);
- Content in the theoretical part of the formulas used in the work;
- Providing additional materials such as tables and graphs and the like;
- Sequence of work;
- Availability of final or test questions.

Before comparing the control groups, a survey was conducted of the teachers who taught these groups (Tab. 1-B). Based on the results of the survey, teachers of scientific research competencies of students and master's degree students, future physics teachers showed the following results. It is shown in lower Figure 5(a).

Figure 5 (a,b).
Teacher surveys: results (%)



a) Results of the first teacher survey b) Results of the final teacher survey

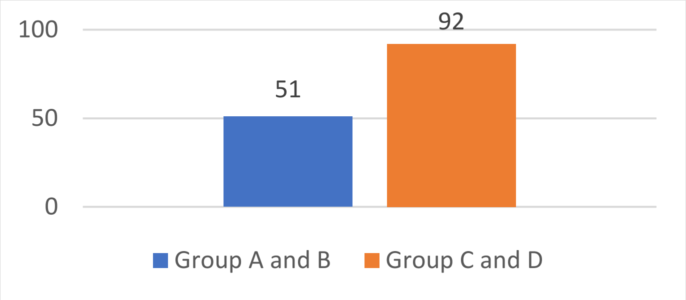
Teachers in absentia determined the main areas of scientific research competencies of their students and undergraduates by responding to a survey. According to the results, the indicator of groups A and B showed 45%, and the level of groups C and D - 55%.

In conclusion, the pedagogical expert once again conducted a survey of teachers studying in groups (Tab. 1-B). That is, we can say that correspondence teachers are the indicators of their students after mastering the educational and teaching aids, in general, the proposed course. It is shown in the figure below (Fig. 5 b).

Thus, the results of the survey for teachers received a positive result when the level of groups A, B increased from 45% to 65%, and the level of groups C, D-s from 55% to 72%. We come to the conclusion that this proves the effectiveness of the proposed special course.

The research work, based on a pedagogical experiment, and the quality of completing the tasks presented in the textbook and educational manual, showed the following results (based on a 100-point calculation indicator) (Fig. 6).

Figure 6.
Quality of completion of tasks presented in the textbook and educational manual (%)



That is, the primary groups A, B showed lower performance than the control groups C, D. In particular, the gap between the control groups was 42%. Let us turn to the fact that this is directly related to the fact that groups A and B acquired only theoretical knowledge.

And we conclude that controlled groups C, D are the result of complete mastery of the physics workshop, which will become an integral part of the methodological foundations for the formation of scientific research competencies of future physics teachers. That is, the proposed workshop has proven its effectiveness. As a result, we conclude that the scientific research competencies of students developed with the formation.

Conclusion

As a result, the need to provide educational and teaching aids for physics workshops and their novelty were proven. That is, the methods that were used in the works, applications presented to help the teacher, namely a graph of the student's progress, a assessment sheet, assessment criteria for laboratory work and their test questions and developmental tasks with suggested lectures and a word cloud, drawing up formulas, physical dictation and so on, so that these recommendations and innovations are based on the topic of the textbook, I concluded that the educational manual will be a contribution to the development of comprehensive work and methodological complex.

The following key findings emerged from the research conducted:

1) The influence of the physics workshop on the formation of scientific research competencies of future physics teachers has been proven by a pedagogical expert and has shown positive results.

2) The positive impact of the proposed innovations on improving research skills was noted.

It should be noted that due to the limited sample of study participants, the findings of the study also have limitations. The research assesses improvements in research skills immediately after the course, but does not analyze long-term retention or application of these skills in professional practice. The study relies on surveys and comparative analysis, which may not fully capture the depth of cognitive and practical skill development. More diverse assessment tools, such as direct observation or longitudinal tracking, could provide richer insights. Also the effectiveness of the physics workshop may be influenced by the availability of equipment, teaching aids, and institutional support. Future research can be applied by expanding the research to compare different teaching methodologies (e.g., traditional lectures vs. research-based workshops), studying the impact of modern digital simulations and conducting similar studies in different educational settings.

Conflict of Interest Statement

The authors declare no potential conflicts of interest regarding the research, authorship, or publication of this article.

Author Contributions

Skakov Mazhyn: Validation, Writing - Review & Editing, Project administration. Choruh Ali: Formal analysis, Supervision. Dalabayev Tleubek (corresponding author): Conceptualization, Methodology, Investigation, Data Curation, Writing - Original Draft, Writing - Review & Editing. Nurizinova Makpal: Software, Resources.

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