

## THEORETICAL AND METHODOLOGICAL FOUNDATIONS FOR THE FORMATION OF STUDENTS' RESEARCH COMPETENCIES IN PHYSICS EDUCATION

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**Abstract.** This article analyzes the theoretical and methodological foundations of forming students' research competencies in physics education. Due to the growing importance of the competency-based approach in the modern educational process, developing students' abilities such as independent inquiry, experimentation, and drawing scientific conclusions has become one of the essential pedagogical tasks. The article examines the structural components of research competence, the role of research activities in physics education, and the ways of developing these competencies through project-based and experimental methods. Furthermore, methodological approaches aimed at developing research competencies in physics lessons are systematically analyzed.

**Keywords:** physics education, research competence, competency-based approach, project method, experiment, scientific thinking, learning activity.

**Introduction.** The modern education system requires not only increasing students' theoretical knowledge but also preparing them for practical activity. Therefore, the competency-based approach is currently considered one of the main methodological directions in education. This approach focuses on students' ability to acquire knowledge independently, analyze it, and apply it in various situations.

Physics occupies an important place in the system of natural sciences and is largely based on studying phenomena through experimentation. Therefore, organizing research activities in physics lessons contributes to the development of students' scientific worldview and analytical thinking. During experimental work, students acquire essential elements of scientific activity such as identifying problems, proposing hypotheses, conducting observations, and analyzing results.

From this perspective, the formation of students' research competencies in physics education is considered one of the important pedagogical tasks.

### **Main Part.**

In pedagogical literature, research competence is interpreted as an integrative quality that includes a student's ability to identify a scientific problem, select appropriate research methods, conduct experiments, and analyze obtained results.

Organizing research activities in physics lessons not only deepens students' theoretical knowledge but also develops their practical skills. For example, laboratory work, small research projects, and problem-based learning methods promote independent thinking among students.

In such activities, students typically perform the following stages:

- identifying the problem;
- proposing a hypothesis;
- conducting an experiment;
- recording results;
- drawing conclusions.

These processes help students approach real scientific research activities.

Research competence consists of four interconnected structural components.

Table 1. Structural Components of Research Competence

Component	Content	Formation Methods
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Cognitive	Scientific concepts and theoretical knowledge	Theoretical analysis, problem questions
Operational	Skills of experimentation and measurement	Laboratory work
Informational	Searching and analyzing information	Use of information technologies
Reflective	Evaluation of activity and drawing conclusions	Self-analysis and reflection

### ***Cognitive Component.***

The cognitive component represents the system of knowledge necessary for students' research activity. It includes:

- physical concepts (force, energy, electric current);
- laws and relationships (Newton's laws, Ohm's law, etc.);
- elementary theoretical knowledge and scientific understanding.

This component forms the basis for understanding the problem, proposing hypotheses, and comprehending the content of research.

### ***Operational Component***

The operational component includes practical skills related to research activities, such as:

- planning research;
- organizing and conducting experiments;
- performing measurements;
- safe and effective use of equipment.

This component determines students' ability to apply theoretical knowledge in practice and plays a leading role in project-based and experimental learning processes.

### ***Information and Communication Component***

The information-communication component characterizes students' ability to work with information and present research results. It includes the following activities:

- searching for information from various sources (textbooks, the Internet, experimental results);
- analyzing and processing obtained information;
- presenting results in the form of tables, graphs, diagrams, and presentations;
- communicating and exchanging ideas within a team.

This component contributes to the development of students' digital literacy and communicative culture.

### ***Reflective and Evaluation Component.***

The reflective-evaluation component reflects students' ability to critically analyze their research activities. It includes:

- drawing conclusions based on obtained results;
- identifying and analyzing errors;
- evaluating their own activity and determining ways of improvement.

### ***Methodological Approaches***

Several methodological approaches can be applied to develop research competencies in physics education, including:

- problem-based learning;
- project-based learning technology;
- experiments and laboratory work;



- the use of information technologies.

These methods actively involve students in the learning process and develop their independent research abilities.

Table 2. Stages of Organizing Research Activities in Physics Lessons

Stage	Content
Problem identification	Determining a question or problem related to the studied phenomenon
Hypothesis	Formulating a tentative scientific assumption
Experiment	Testing through laboratory work or observation
Analysis	Processing and analyzing obtained results
Conclusion	Drawing scientific conclusions

**Conclusion.** In conclusion, the formation of students' research competencies in physics education is one of the key directions of modern education. Integrating research activities into the teaching process develops students' scientific thinking, promotes independent learning skills, and contributes to the formation of competencies necessary for future scientific activity.

Therefore, it is advisable to widely apply research methods, project-based technologies, and experimental activities in physics lessons.

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