

## **Improving the Research Competence of Students in Physics (On the Example of Teaching Semiconductor Physics)**

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### **Abstract**

*The development of the didactic provision of an improved methodology for the formation and objective assessment of the level of preparation for research activities of future physics teachers based on a competency-based approach serves to develop the component nature of future physics teachers.*

*This article provides information about the organization of experimental work on the formation of research competencies of future physics teachers, professional tasks of a research nature of various levels of complexity; mastery of research technology.*

**Key-words:** Student, Competence, Research Competence, Physics, Model, Experimental Problem, Experiment, Device.

### **1. Introduction**

Despite the large-scale reforms carried out in our country aimed at improving the quality of higher education, further intensification of the training of future specialists on the basis of new approaches remains relevant. The Strategy of Actions for the Further Development of the Republic of Uzbekistan defines such a task as "improving the quality and efficiency of the activities of higher educational institutions through the introduction of international teaching standards and assessing the quality of teaching" [1]. In this regard, it is important to improve the research competence of students in physics, taking into account the needs of social customers and expanding the possibilities of introducing pedagogical and information and communication technologies into the educational process.

The peculiarities of the development of modern society and education from the point of view of overcoming the problems of improving the quality of training, require new methods for organizing the educational process, new qualities of a graduate of higher educational institutions, who must come into the world capable of independently solving many pedagogical issues, finding optimal solutions to problem situations ... All this can be taught to the future physics teacher by research activities in teaching the section of semiconductor physics [3. p. 157].

## **2. Analysis of Literature on the Topic**

“Competence” and “competence” are often discussed concepts in pedagogy. In the research, the following working definition is adopted, by competence it is necessary to understand a person who has greater knowledge, skills and abilities compared to other.

The concept of "competence" includes the concepts: knowledge, skills and abilities. Competences relate to human activity, competence characterizes the subject of activity. Competence and competence reflect the integrity and integral essence of the result of education at any level and in any aspect [4. P. 21].

The issues of studying and analyzing the essence and content of the concepts of "competence" and "competence", the formation of research competencies of students have been studied by such domestic scientists as G.E. Karlybaeva, O.A. Kuisinov, A.Kh. Makhmudova, N.A. Muslimov, M.B. Urazov and such scientists of the countries of the commonwealth of independent states as V. Baidenko, A. Verbitsky, E. F. Zeer, A. K. Markova, I. V. Podlasiy, A. V. Khutorsky, V. D. Shadrikov and others.

The issues of preparing students for research activities have been studied in the studies of such domestic scientists as I.B. Askarov, B.Kh. Rakhimov, Sh.S. Sharipov, as well as by such scientists of the countries of the commonwealth of independent states as I.A. Zimnyaya, I. J. Lerner and others.

The methods of organizing the research activities of students and the formation of their research competence have been studied in detail in scientific research of such scientists from foreign countries as W. Hutmacher, M. Connell, J. Hartig, E. Klieme, H.P. Kelz [9. p. 26].

## **3. Research Methodology**

The formation of students' research competencies is one of the main directions of the development of general education at the present stage, a strategic task in the theory and practice of pedagogy.

Research competence is an interconnected complex of certain competencies of personal qualities combining knowledge, abilities, skills, individual abilities in the field of educational or scientific research and solving pedagogical problems. It is necessary for the future physics teacher both in the learning process and at the exit to pedagogical activity [2. P.21].

Based on the analysis of scientific and methodological literature, it was determined that the structure of students' research competence consists of the following components: motivational, cognitive, technological.

The motivational component includes a system of motivationally holistic and emotional-sensual attitudes of students to the world around them, themselves and their personal capabilities. This component of research competence makes it possible to manifest needs for cognitive activity [10. P. 27].

The cognitive component guarantees the formation of a scientific picture of the world in the student's mind. In research activities, this is reflected in the following characteristics and features: the ability to apply research technology in practice; ask questions, look for the foundations and causes of phenomena, express your point of view on the issue or express your lack of understanding of the issue; analysis of the data obtained and formulation of conclusions [8. P.58].

The technological component includes the following research skills related to research activities: be able to outline, problem formulation, goal formation, planning, search and interpretation of information in the research process.

#### **4. Analysis and Results**

Let us dwell on the disclosure of research competence as an interconnected complex of research competencies in the individual models of research activity developed by us.

The content of the first model "Problem - an algorithm for solving the problem" is as follows. A problem is put forward (for example, the topic: Intrinsic conductivity of semiconductors) and further theoretical material is studied, information on this topic is analyzed. An idea is born, in accordance with which an algorithm for solving the problem is constructed.

This model improves the following research competencies:

- Identifying ways to solve the proposed problem.
- Analysis of the literature on the problem.
- Constructing a model or proposing a circuit.

- Making calculations.
- Assessing the effectiveness of the proposed model.

The essence of the second model "Physical phenomena" helps students to see the world of semiconductor physics. In this model, physical phenomena are investigated and explained from the point of view of the integration of science. According to the second model, topics such as "Physics of semiconductors and chemistry", "Physics of semiconductors and mathematics", etc., can be proposed for independent study [5. P. 114].

Research competencies in this model:

- Study of the physical essence of the selected object or phenomenon;
- Elucidation of the physical essence of an object using theoretical knowledge or by performing experiments;
- Study of the possibility of further use of semiconductor materials;
- Evaluation of the properties of semiconductors from the point of view of physics.

The study of the third model "Theory - experimental problem" is carried out according to the following scheme. The theoretical material of the selected object (for example, "Diode" or "Transistor") and literature on this object are studied (in this case, interesting facts from the history of the development of semiconductor physics may arise). After the analysis of literatures, experimental research problems concerning this object are solved.

Research competencies in this model:

- Selection of an object;
- Study of the theory of the object;
- Study of the physical properties and characteristics of the selected object;
- Solving research experimental problems;
- Conducting experiments;
- Evaluation of the spectrum of application of semiconductors in the life of people.

In the fourth model "Experimental device" we proceed from the fact that the most important is the transition from the theoretical prediction of certain regularities of semiconductors to its experimental verification (For example: diode rectifier).

Research competencies in this model:

- Finding out on the use of what physical phenomena and laws the operation of this device is based, what are its purposes, conditions of use, requirements for it, etc .;
- Identification of the most expedient (simple) constructive solution;
- Preparation of a sketch and drawing of the device;

- Manufacturing of the device itself;
- Study of the possibility of using the device in laboratory work in physics, in everyday life and technology;
- Assessment of the characteristics of experimental devices in the setting of physical workshops.

In the fifth model "Experimental problem - physical experiment" is as follows: an experimental problem is taken from a collection of problems in physics and its theoretical solution is verified using physical experiments.

Research competencies in this model:

- Verification of the theoretical solution of the experimental problem using a physical experiment;
- Selection of a problem or problem from a collection of problems in physics;
- Setting up an experiment to verify the situation described in the experimental problem;
- Analysis of theoretical and experimental results;
- Conducting an assessment of the correspondence of theoretical conclusions to the results of the experiment.

Observation of some of the phenomena of semiconductor materials may become impossible due to their transience. The use of information and communication technologies allows future teachers to successfully complete educational and professional tasks of a research nature and develop their research competencies related to professional activities. Creation of a computer model of the investigated phenomenon, described in the experimental problem of a physical situation, close to real phenomena is one of the main methods of teaching physics. The content of the sixth model "Computer model of semiconductor materials" is the application of this method in teaching students research activities in the physics of semiconductors. The student can create his own models of physical phenomena of semiconductors and conduct a computer experiment with automatic display of the physical processes of semiconductor materials in the form of computer animation. [6. P. 110].

Research competencies in this model:

- Simulation of physical situations described in the problem statement, or the creation of a computer model of a full-scale experiment;
- Simulation of the physical situation described in the problem statement (or recreation of a full-scale experiment using a computer model);

- Comparison of the theoretical solution of the problem and the results of modeling on a computer (or comparison of the results of full-scale and computer experiments);
- Evaluation of the results of research activities.

The levels of improvement of research competencies are determined as a result of complex observation, the unity of theory and practice, testing, taking into account the effectiveness of students' performance at seminars; assessment of the success of students' teaching in physics at the university, which is reflected in the performance indicators [7. P. 142].

## 5. Conclusions

Thus, in the course of the research it was determined that the main factors for the successful formation of research competencies of future physics teachers are: the existence of specific conditions for organizing the process of forming research competencies; the existence of experience in the application of research competencies to solve various experimental problems; the existence of an idea of the importance of developing research competence in future physics teachers.

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