THE IMPORTANCE OF INTERDISCIPLINARY INTEGRATION IN THE DEVELOPMENT OF EXPERIMENTAL COMPETENCE OF STUDENTS

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Annotation:
This article shows the role and importance of the methodology of using the integration of interdisciplinary, internal and integration between types of training in laboratory classes to improve the experimental competence of future physics teachers.

Keywords: Crocodile Physics, PhET Simulations, Adobe Flash Player, Diffraction, LED, Planck constant, internal and interdisciplinary integration, integration between types of training, competence.

As you know, the main goal of the education reform is to train mature specialists for the social and industrial spheres. And at the heart of the personnel training system, an important place is occupied by the general link of secondary education of the system of continuing education. This circumstance, in turn, places great responsibility on pedagogical institutions of higher education, which train specialists for general secondary education. From this point of view, pedagogical scientific research to improve the effectiveness of education is one of the urgent problems of our time, and a lot of work is being done in this direction.

This article presents a methodology for using the integration of interdisciplinary and internal connections in the development of experimental competence of students in laboratory classes in the discipline "physics of the atom, nucleus and elementary particles" in the training of future physics teachers in pedagogical universities.

Physical science as the basis of technology and production techniques is studied for specialties in various fields. Laboratory classes are of particular importance for the honed and in-depth study of this science. Conducting these classes requires a subject teacher to be highly skilled and creative. In many cases, laboratory testing is limited to performing certain measurements and comparing the results with the results of other measurements or a reference value, as well as evaluating the measurement error. In fact, if we consider physics as part of the production technology of each laboratory work, a creative approach to its study will be necessary. With this approach, the studied laboratory training should be comprehensively analyzed taking into account scientific, interdisciplinary integration, and links with production.

Let's consider the methodology for the formation of experimental competence of students in laboratory classes using the example of the laboratory work "determination of the Planck constant" in the discipline "physics of the atom, nucleus and elementary particles". Many laboratory works on the determination of the Planck constant have been prepared and are used in the educational process. A semiconductor LED was used in laboratory studies to determine the Planck constant analyzed in this article [2].

In the course of this laboratory work on determining the Planck constant, it is necessary to focus on interdisciplinary and internal integration in the perfect formation of students' professional competence on the topic under study. In the laboratory work under study, internal connections exist between the sections of nuclear physics and electromagnetism, nuclear physics and optics, and before performing the work it is necessary to form clear ideas about these connections. For example, it is necessary to study in detail the structure and principle of operation of a semiconductor diode used in laboratory work, the main characteristics, as well as the electrical circuit of the device. The change in the resistance values in the electrical circuit and the change in the voltage of the diode, as well as the current flowing through it, must be studied by the volt-ampere characteristic of the diode. At this point, for the formation of professional competence, it becomes important that the student can work normally only at a constant $U \pm 0.01U_{rat}$ voltage, at which the LED used in the device is designed for a certain voltage ot((U_{rat}), and throughout the entire experience he realized that the frequency of LED radiation cannot be increased by increasing tension. The initial stage of the formation of students' experimental competence in performing laboratory work is internal integration, i.e. the application of knowledge gained at the Department of Electromagnetism of General Physics to the study of the phenomena of the microcosm. At the second stage of laboratory work, internal integration is carried out, emphasizing the need for acquired knowledge on diffraction and interference phenomena, wave coherence conditions, structure and principle of operation of the diffraction grating, studied in the Optics section of the general physics course. Table 1 shows the mechanism of implementation of internal and interdisciplinary integration in the studied laboratory work.

Table 1 Internal and Interdisciplinary Integration in Teaching the Laboratory Exercise to Determine the Planck Constant

Internal and Subject Connection		Interdisciplinary Communication	
Electromagnetism	Optics	Mathematics	IT
• Structure and principle of operation of the LED (LED)); • · p-n transition base; • · Recombination of charge carriers; • · Output of radiation quantum in the process of recombination; • · A working formula for determining Planck's constant. $h = eU_L / \nu$ (1)	• The concept of diffraction grating; • Huygens-Fresnel principle; • Mutual coherence of secondary rays; • Diffraction beam interference; • Wolf-Bragg law. $d\sin\theta_n = \pm k\lambda$, (2) In here $k = 0, \pm1, \pm2$ ...	• For small corners $tg\theta_n \approx \sin\theta_n$. • $tg\theta_n \approx \frac{x_k}{L}$ (3) x_k- k the distance between the maxima of the order, L is the distance from the diffraction grating to the screen. $\lambda = \frac{x_k \cdot d}{L}$. (4) $\nu = \frac{k \cdot L \cdot c}{x_k \cdot d}$ (5) • The basic working formula for determining Planck's constant is: $h = \frac{eU_d}{\nu} = \frac{eU_d \cdot x_k d}{kL \cdot c}$ (6) where c is the speed of light in a vacuum.	• Adobe Flash Player animation; • Crocodila Physics Physics Simulator; • PhET Simulations Simulator; • The Microsoft Excel program.

The presence of a student's knowledge of mathematics in equations, proportions, and trigonometry in a laboratory lesson determines the integrative relationship between these disciplines. The use of virtual machine software in laboratory work ensures the integration of information computer technologies (ICT) and nuclear physics [3]. The electrical schematic of the laboratory device can be assembled using Crocodile Physics, PhET Simulations simulators to assemble electrical circuits, change circuit parameters, and study the volt-ampere characteristic of the LED. , By studying the volt-ampere characteristic of the diode, processing the results through Microsoft Excel and graphically analyzing the results obtained, the integration between nuclear physics, mathematics and ICT is ensured.

In laboratory classes, it is necessary to carry out not only internal and interdisciplinary integration, but also integration between types of study in order to perfectly study the subject being studied. In fact, integration between types of learning has been around for a long time, and while self-actualization is observed, the emphasis on this integration is one of the main factors in learning effectiveness. When integrating between lectures, practical and independent study sessions, the laboratory work should contain theoretical data related to the topic, questions on the topic, as well as specific tasks for self-study [4]. Table 2 shows an example of the tasks required to integrate between the types of learning related to the topic.

Table 2 Integration of Learning Between Learning Types in Lab Sessions

Integration Between Types of Learning		
Lecture session	**Hands-on training**	**Self-directed education**
Explain the Huygens-Fresnel principle? What is the phenomenon of diffraction? What is the sequence of spectra generated on the screen, and why? Why Does A Semiconductor Diode Conduct Electricity In One Direction? What is the wavelength of the LED you are using?	If the wavelength you are generating is λ= 0.4 μm, calculate the limit voltage to turn on the laser.	- Create lab animations using Adobe Flash Player. - The advantages of Crocodile Physics are the creation of a simulation of the diffraction phenomenon. - Assembling an Electrical Circuit with the PhET Simulations Simulator. - Generate data in Microsoft Excel as spreadsheets.

Inference

By using the integration between the types of training in the lab sessions, the following results are achieved:

- a basis will be created for the student to repeat the knowledge gained on the topic, as well as for their re-study;
- In the process of calculating the results of laboratory tests, students develop skills for solving targeted practical problems;
- With the proper organization of self-study, students develop skills in working with textbooks and scientific literature, periodicals, Internet sites, as well as skills in working with computer programs of various levels;

From the above analysis, it can be seen that the implementation of the integration of interdisciplinary, internal and interdisciplinary types of education in laboratory classes in atomic and nuclear physics leads to an increase in the professional competence of future physics teachers not only in the studied section, but also due to the perfect reproduction of knowledge in other sections of general physics and other disciplines.

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