METHODS OF ORGANIZING LABORATORY TRAINING IN THE COURCE FOR MECHANICS USING MODERN INFORMATION TECHNOLOGIES

Maxmudova Nafosat Vali qizi
Master's Student Jizzakh State Pedagogical University
E-mail: nafosatmaxmudova@icloud.com

Abstract
In our paper we examine the problem of increasing the effectiveness of training specialists in educational institutions. It is shown that the professional readiness of students as a personal quality and an essential prerequisite for the effective activity of a specialist, the successful performance of their duties, the correct use of knowledge and experience, helps to quickly adapt to working conditions and promotes further professional development.

Keywords: Laboratory classes, development of educational and professional practical skills, form of educational classes.

Introduction

It is well known that laboratory classes as types of educational classes are aimed at experimental confirmation of theoretical provisions and the formation of educational and professional practical skills, and constitute an important part of theoretical and professional practical training [1]. A laboratory class is a form of educational class in which, under the guidance of a teacher, students personally conduct natural or simulation experiments in order to verify and confirm individual theoretical provisions of an academic discipline, acquire practical skills in working with laboratory equipment and computing technology. Laboratory classes are held in educational workshops and laboratory classrooms. The duration of a class is at least two academic hours. The performance of laboratory work is preceded by a check of students' knowledge - their theoretical readiness to complete the task. For each laboratory work, methodological guidelines for its implementation have been compiled and approved, as well as assessment criteria that take into account the volume, correctness, rationality, accuracy, and independence of completing tasks [2]. Works of a reproductive nature are distinguished by the fact that when carrying them out, students use detailed instructions that indicate: the purpose of the work, explanations (theory, main characteristics), equipment, apparatus, materials and their characteristics, the order of performing the work, tables, conclusions (without formulation), test questions, educational and specialized literature.

When conducting laboratory work of a partially exploratory nature, students do not use detailed instructions, they are not given the order of performing the necessary actions, this requires them to independently select equipment, choose methods for performing the work in instructional and reference literature, etc. [1.2]. Work of an exploratory nature is characterized by the fact that students, relying on their existing theoretical knowledge, must solve a problem that is new to them.

Physical experiment is one of the main sources of knowledge

In physical science, a distinction is made between research and criterial experiments. Such a division is also possible in an educational physics experiment. When setting up experiments in a research plan, students will receive data that has subjective novelty. A criterial experiment aims to obtain an expected result that confirms or refutes the stated assumptions or the consequences deduced by theory. The following features are inherent in any type of experiment: intervention in phenomena, processes of the external world by special devices; allocation of the actually studied connections and elimination (muffling) of side and random influences; reproduction and multiple repetition of the studied phenomena under certain conditions; systematic change in the conditions of the phenomenon or process; organization and direction in order to minimize the elements of chance [3].

Structurally, a physical experiment can be divided into three components: the experimenter and his activity as a cognitive subject; the object or subject of experimental research; means of experimental research (instruments, devices, experimental setups, etc.). In the relationship of these three structural elements, the first of them represents the subjective, and the second and third – the objective side of the experiment. From a methodological point of view, it follows that the objective side of the experiment is not limited to the subject of experimental research alone. It (the objective side) includes the means of experimentation that isolate, record, prepare and transform the object. The decisive role of the means of experimental research lies in the fact that all the above-mentioned features of the experiment can be realized only thanks to these means. The use of devices makes it possible to expand the natural limitations of the human sense organs, reflecting the external world in a relatively narrow range of phenomena and properties caused by the adaptation of the organism to the environment [4].

An educational physics experiment is simultaneously a source of knowledge, a teaching method, and a type of visualization. An educational experiment is created and improved in accordance with the development of physics teaching methods. In general , in teaching physics, the following important tasks are assigned to a school experiment: ensuring the best possible assimilation of concepts, laws, and theories by students; developing the ability to apply knowledge in practice; familiarization with the most important methods of studying nature; systematization, processing, and transmission of information; developing students' interests in the subject and preparing them to master new equipment and technology for material production; developing students ' skills for independent work and a creative attitude to work; developing practical skills and abilities, preparing for work in the sphere of material production [5].

At present, the university has an established system of educational physics experiments based on the idea of gradually increasing the independence of students in the process of acquiring knowledge. Based on this, the physics experiment can be divided into five types according to the increasing degree of complexity for students and decreasing current control by the teacher: a demonstration experiment conducted by the teacher [5,6]; frontal laboratory work performed by students in the process of studying the program material; physics practical work performed by students at the end of the previous sections of the physics course or at the end of the entire school physics course; experimental tasks; extracurricular physics experiments (at clubs, conferences) and home experimental work.

This classification of the experiment is not the only one, but the essence of all existing classifications basically comes down to it. In addition to the general tasks solved by all types of school experiments, each type has its own peculiarity, its narrower target purpose. All these five types of physical experiments contribute to a deeper study of the laws of physics, as well as the acquisition of practical skills in the field of physical experiments by students.

Thus, a physical experiment is one of the main sources of knowledge in studying the world around us and one of the most important methods of teaching physics. Depending on the task, it can be carried out as a research or as a criterial one and always has two sides: subjective and objective, with the latter playing a decisive role in it [6]. As a teaching method, it can be divided into five types: a demonstration experiment; frontal laboratory work; physical practical work; experimental tasks; extracurricular physical experiments, each of which, in the integral system of a physical experiment, in turn contributes to a deeper study of the laws of physics, as well as the acquisition of practical skills by students.

Use of ICT laboratory classes

The use of ICT in laboratory classes allows to increase the interest of students in laboratory classes, implement interdisciplinary connections, improve skills in using a personal computer, and form the corresponding general competencies of students. It should be noted that laboratory classes are an important stage in the formation of general and professional competencies of students, which are developed during educational and industrial practices in production conditions, at enterprises of social partners.

The students perform laboratory work with the aim of [7] :

development of practical skills in accordance with the requirements for the level of training of students established by the working program of the discipline/professional module for specific sections/topics of disciplines or interdisciplinary courses;

generalization, systematization, deepening, consolidation of the acquired theoretical knowledge;

improving the skills to apply acquired knowledge in practice, realizing the unity of intellectual and practical activities;

development of intellectual skills in future specialists: analytical, design, constructive, etc.;

development of such professionally significant qualities as independence, responsibility, accuracy, creative initiative in solving assigned tasks.

Teachers plan the assignments for laboratory and practical classes so that they can be completed well by the majority of students in the allotted time [8]. A laboratory class is a class during which students complete one or more laboratory assignments under the guidance of a teacher in accordance with the educational material being studied.

Students' performance of laboratory work (assignments) is aimed at:

generalization, systematization, deepening, consolidation of acquired theoretical knowledge;

development of skills to apply acquired knowledge in practice;

implementation of the unity of intellectual and practical activities;

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development of intellectual skills: analytical, design, constructive, etc.;
development of such professionally significant qualities as independence, responsibility, accuracy, and creative initiative when solving assigned tasks. The disciplines for which laboratory and/or practical classes are planned, as well as their volumes, are determined by the educational standards of secondary vocational education, and working curricula for the areas of professional education being implemented.

Planning laboratory classes

Planning of the quantity and content of laboratory classes is carried out by the developer of the working program of the discipline (course), based on the requirements of the relevant federal state educational standard for the results of mastering the discipline (course), as well as the applied educational technologies and methods. When planning the content of laboratory work, one should proceed from the fact that laboratory work has different didactic goals. The main didactic goal of laboratory work is the experimental confirmation and verification of theoretical provisions (laws, dependencies). The content of laboratory work can be the experimental verification of formulas, calculation methods, establishment and confirmation of patterns, familiarization with the methods of conducting experiments, establishment of the properties of substances, their qualitative and quantitative characteristics, observation of the development of phenomena, processes, etc. [7].

When choosing the content and volume of laboratory work, one should proceed from the level of complexity of the educational material, from the connection between disciplines and courses, the significance of the theoretical provisions being studied for the upcoming professional activity, from the place that a specific work occupies in the totality of laboratory work and what its role is in the formation of a holistic idea of the content of the academic discipline (course). When planning laboratory work, one should take into account that, along with the leading didactic goal (confirmation of theoretical provisions), in the course of performing the work, students develop practical skills and abilities in the use of various devices, installations, laboratory equipment, apparatus (which can be part of professional practical training), as well as research skills to observe, compare, analyze, establish dependencies, draw conclusions and generalizations, independently conduct research, and formalize the results [7, 8].

The content of laboratory work must be planned in such a way that, taken together for a discipline (course), they cover the entire range of professional skills that the given discipline (course) is aimed at mastering, and include solving various types of problems, including professional ones (analysis of production situations, solving situational production problems, performing professional functions in business games, etc.), performing calculations, computations, drawings, working with measuring instruments, equipment, apparatus, working with regulatory documents, instructional materials and reference books, drawing up design, planning and other technical and special documentation, etc. Along with the formation of skills and abilities in the process of laboratory work, theoretical knowledge is generalized, systematized, deepened and concretized, the ability and readiness to use theoretical knowledge in practice is developed, intellectual skills are developed [9].

In general, the list of planned laboratory work should maximally facilitate the fulfillment of the requirements for the results of mastering the main professional educational program, for knowledge, skills and practical experience, for the level of training of graduates, established by the relevant federal state educational standards, as well as by the educational organization itself (when distributing the variable part). The share of academic hours planned for conducting laboratory classes in the total volume of academic hours allocated in the curriculum for mastering a discipline (course) has no regulatory restrictions and may be different for different disciplines (courses) [10]. The content of laboratory work, as well as the content of assignments for practical classes, should be planned on the basis of a preliminary calculation of the time required for their high-quality completion by the majority of students.

Organization and conduct of laboratory classes

Laboratory classes are usually held in specially equipped educational laboratories (Fig. 1). Duration is not less than one academic hour. Duration of practical classes in academic disciplines of general professional and professional cycles is not less than two academic hours, in general education disciplines, academic disciplines of general humanitarian and socio-economic, general mathematical and natural science cycles - not less than one academic hour [11].

Fig. 1. Specially equipped educational laboratories.

Laboratory classes are preceded by checking the students' knowledge and their theoretical readiness to perform laboratory work. Automated test control can be one of the forms of monitoring the students' readiness to perform laboratory work. In order to prepare students for laboratory work, the teacher, as a rule, informs the students of the topic of the work and determines homework, including repetition of the theoretical material necessary for completing the work, preparation of a report form on the results of the work, etc. [12].

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In addition to independent work of students, the necessary components of laboratory classes are:
instructions given by the teacher before the start of the lesson;
discussion of the results of the laboratory work;
assessment of completed laboratory work (assignments), the degree of students' mastery of the necessary skills, and practical experience.

In order to increase the efficiency of laboratory classes, in which one or more assignments are performed, it is advisable to develop collections of exercises, accompanied by methodological instructions, which take into account not only the
level of readiness of students to perform assignments of a particular level of complexity, but also the profession or specialty being acquired (for general education disciplines) [11, 12]. When conducting laboratory classes, frontal, group and individual forms of performing laboratory work (assignments) can be used. In the frontal form, all students perform one work (or one assignment). In the group form, individual groups of students perform different works (different assignments). In the individual form, each student performs an individual laboratory work (individual assignment).

When using various forms of laboratory classes, it is necessary to take into account that the most effective independent activity of the student in completing the full volume of work is ensured by using a predominantly individual form of completing the work (assignment). Since laboratory classes are aimed at developing students' skills and practical experience, as well as ensuring a high level of intellectual activity, it is advisable to plan them based on the optimal ratio of different types of work [13]:
works in which students use detailed instructions that indicate the purpose of the work, provide explanations (theory, main characteristics), equipment, apparatus, materials and their characteristics, the order of performing the work, table forms, the structure of conclusions, test questions, educational and specialized literature (i.e. works of a reproductive nature);
work in which students do not use detailed instructions containing the order of necessary actions, and they are required to independently select equipment, choose methods for performing work in instructional and reference literature, etc. (i.e. work that is partially exploratory in nature);
work in which students solve a problem that is new to them, relying on their existing theoretical knowledge (i.e. work that is of an exploratory nature. In order to ensure the effective use of time allocated to laboratory classes, it is advisable to carry out a preliminary selection of additional tasks and assignments for students working at a faster pace [14].

Registration of laboratory work

To perform laboratory work, teachers develop appropriate methodological materials (instructions), for their implementation, they are reviewed and accepted by the relevant subject (cycle commissions) and approved by the deputy directors for educational and methodological work, which are part of the main professional educational program [15,16]. Methodological instructions are developed for each laboratory work provided for by the working program of the academic discipline: in accordance with the number of hours, requirements for knowledge

and skills, the topic of laboratory and practical work (assignments), established by the working program of the academic discipline in the relevant sections (topics).
For example, guidelines for conducting laboratory work may include:
title (topic) and number of the laboratory work;
the purpose of the laboratory work;
basic safety requirements when performing laboratory work;
brief theoretical information necessary for completing the laboratory work works;
a list of equipment, reagents, etc. required to perform laboratory work;
the procedure for performing laboratory work;
requirements for the presentation of the results of laboratory work (report);
control questions;
homework;
literature used (bibliography).
Methodological instructions for completing several laboratory assignments in a discipline (course) can be combined into a single methodological manual, including:
title page;
general safety instructions when performing laboratory (practical) work;
general instructions for performing laboratory work and/or an algorithm for performing it;
appendices, if additional materials, including reference materials, are required to complete laboratory work;

literature used (bibliography);
content (if the volume of methodological instructions, for example, is more than 10 pages).
Laboratory work . Study of gyroscope precession
Purpose of the work
Study of the phenomenon of gyroscope precession.
Tasks to be solved :
determination of the dependence of the angular velocity of precession on the angular velocity of rotation of the gyroscope (Fig. 2.);
determination of the dependence of the angular velocity of gyroscope precession on the applied torque;
experimental measurement of the moment of inertia of a gyroscope; theoretical calculation of the moment of inertia of a gyroscope.

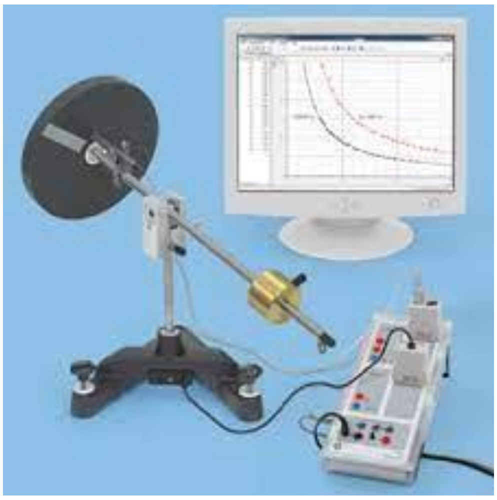

Fig. 2. Determination of the dependence of the angular velocity of precession on the angular velocity of rotation of the gyroscope;

6.2 Experimental setup

Devices and accessories:

Gyroscope (disk mass = 1500 g, diameter = 230 mm); Set of loads;

Cord for spinning the gyroscope; CASSY Computer Interface Sensor; Computer.

A gyroscope is a symmetrical one that rotates rapidly around an axis of symmetry (axis z in Fig. 3). Since the axis of rotation coincides with the axis of symmetry of the gyroscope, its angular momentum is equal to:

$$L = I3\omega, \quad (1)$$

where I3 is the moment of inertia of the gyroscope relative to the axis z , ω is the angular velocity of rotation. From expression (1) it is evident that the axis of rotation coincides with the direction of the vector of the angular momentum of the gyroscope L . The approximate theory of the motion of the gyroscope assumes (Fig. 3) that small moments of external forces cannot change the magnitude of the angular momentum L , but only change its direction.

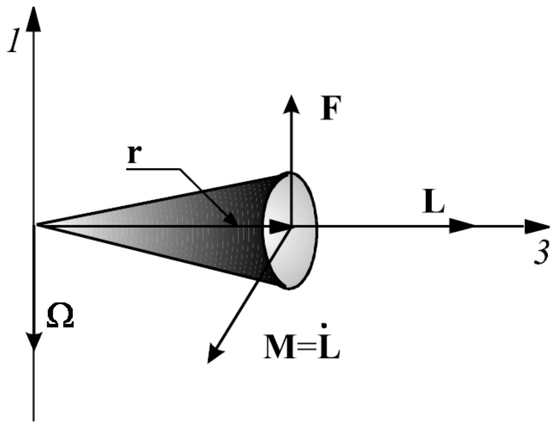

Fig. 3. To determine the angular momentum of a gyroscope

The angular momentum of a gyroscope obeys the fundamental law of rotational motion:

$$\frac{dL}{dt} = M,$$

(2)

Where M is the total moment of external forces. Let us consider this equation as applied to a gyroscope fixed at one point. Let us assume that the point of application of the force lies on the axis of symmetry (see Fig. 3), and the force is directed perpendicular to the axis of symmetry z . Then the moment of this force is directed perpendicular to the axis of rotation of L . Under the action of the moment of constant force, the vector L , and therefore the axis of the gyroscope, must perform a uniform rotation around the axis I . This rotation is called forced precession. The angular velocity of precession Ω can be found from the following considerations. Since the vector L does not change its length, the change in this vector dL over time dt is due exclusively to its rotation with velocity Ω and is determined by the expression:

$$\frac{dL}{dt} =[\Omega\times L],$$

(3)

From a comparison of equations (2) and (3) we have:

$[\Omega\times L]= M,$

or in scalar form for this case:

$$\Omega= \frac{M}{L} = \frac{Fr}{I3\omega}.$$

(4)

Therefore, when fixing only one point, the gyroscope axis can move in space in any direction depending on the direction of the moment of the external force. Such a gyroscope is called free. The angular frequency of precession of a free gyroscope is directly proportional to the moment of the external force and inversely proportional to the frequency of rotation of the gyroscope around the axis of symmetry.

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Conclusion

The use of information and communication technologies in laboratory classes allows to increase the interest of students in laboratory classes, implement interdisciplinary connections, improve skills in using a personal computer, and form the corresponding general competencies of students. It should be noted that laboratory classes are an important stage in the formation of general and professional competencies of students, which are developed during educational and industrial practices in production conditions.

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