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LABORATORY PRACTICUMS AS THE MAIN FORM OF INTEGRATION OF STUDENTS' THEORETICAL AND METHODOLOGICAL KNOWLEDGE AND PRACTICAL SKILLS

PRÁTICAS LABORATORIAIS COMO PRINCIPAL FORMA DE INTEGRAÇÃO DOS CONHECIMENTOS TEÓRICOS E METODOLÓGICOS E HABILIDADES PRÁTICAS DOS ALUNOS

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ABSTRACT

The purpose of the academic paper is as follows. The formation of students' experimental skills and research skills in the process of performing frontal laboratory works is one of the main factors in implementing the State Standard of Higher Education. However, a successful solution to this issue is possible only if there is a clear organization of laboratory work and an effective methodology for conducting it. It is obvious that using an independent experiment is extremely useful for students since it provides a systematic approach to implementing productive ways of cognition and forming the basis of learning activities in the process of performing frontal laboratory works. Thus, the main goal of the program is to prove that the development of laboratory skills will be facilitated by a new approach to organizing learning activities based on the simultaneous use of two textbooks: a textbook and a printed laboratory workbook. This research aims to study the features of laboratory practicums as the primary form of integration of students' theoretical and methodological knowledge and practical skills. The research was carried out using a set of complementary methods that ensured the effectiveness and scientific reliability of the research results, namely: theoretical – analysis, systematization and comparison of the provisions of scientific and pedagogical literature to reveal the state of the problem under consideration, to clarify the essence of reflecting and implementing educational technologies in the educational process; generalization and systematization – to substantiate the theoretical fundamentals of the research; pedagogical observation – to diagnose the level of future specialists' training after a series of activities on the example of analyzing the algorithm of laboratory works. The paper proves that laboratory activities help students to master learning material better. In the process of performing laboratory and experimental works, formulas, calculations, and theoretical provisions that seemed incomprehensible become quite specific. At the same time, many details and facts are revealed that students had no idea about before, and meanwhile, they contribute to the identification and explanation of complex scientific issues. It is emphasized that due to the research nature of laboratory and practical work, students approach them with great interest, gain solid knowledge, are convinced of the reliability of the knowledge they have received, and acquire knowledge that has the power of conviction. It has been proven that the effectiveness of this type of work can be increased by providing informative cards. These include brief theoretical summaries that allow students to quickly find the necessary information (in the context of laboratory activities, this may include help on specific functions, algorithm fragments, structure blanks, and program templates), and clear work structuring. Formalizing the approach and breaking down the solution process into clear, discrete steps makes obtaining specific results quickly and predictably possible. In addition, having such a structure makes it easier for educators to monitor and track the progress of their work. After a long development, laboratory and practical classes have been continuously improved. Today, this form of organizing the educational process in high school is becoming a means of educating future experimentalists, who not only practically prove the probability of many bold hypotheses but also identify new ways of creative search. The efficiency of this type of work can be improved by providing work with informative cards. These are short theoretical summaries that allow students to quickly find the information they need (in terms of laboratory activities, there may be help on specific functions, algorithm fragments, structure blanks, and program templates) and clear structuring of the work. A formalized approach to the solution and the process breakdown into clear, discrete steps makes obtaining certain results quickly and predictably possible. In addition, such a structure makes it easier for educators to monitor and track the progress of their work.

Keywords: Laboratory activities. Integration. Teaching methods. Practicums. Higher education.

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RESUMO

O objetivo do trabalho acadêmico é o seguinte. A formação de habilidades experimentais e habilidades de pesquisa dos alunos no processo de realização de trabalhos de laboratório frontal é um dos principais fatores na implementação do Padrão Estadual de Ensino Superior. No entanto, uma solução bem-sucedida para esse problema só é possível se houver uma organização clara do trabalho de laboratório e uma metodologia eficaz para conduzi-lo. É óbvio que o uso de um experimento independente é extremamente útil para os alunos, pois fornece uma abordagem sistemática para implementar formas produtivas de cognição e formar a base das atividades de aprendizado no processo de realização de trabalhos laboratoriais frontais. Assim, o principal objetivo do programa é provar que o desenvolvimento das competências laboratoriais será facilitado por uma nova abordagem de organização das atividades de aprendizagem baseada na utilização simultânea de dois livros didáticos: um livro didático e um livro de exercícios de laboratório impresso. Esta pesquisa tem como objetivo estudar as características dos estágios de laboratório como a principal forma de integração dos conhecimentos teóricos e metodológicos e habilidades práticas dos alunos. A investigação foi realizada recorrendo a um conjunto de métodos complementares que garantiram a eficácia e a fiabilidade científica dos resultados da investigação, nomeadamente: teóricos – análise, sistematização e comparação do disposto na literatura científica e pedagógica para revelar o estado do problema em causa, para clarificar a essência da reflexão e implementação das tecnologias educativas no processo educativo; generalização e sistematização – para fundamentar os fundamentos teóricos da pesquisa; observação pedagógica – para diagnosticar o nível de formação dos futuros especialistas após uma série de atividades sobre o exemplo de análise do algoritmo de trabalhos de laboratório. O artigo comprova que as atividades de laboratório ajudam os alunos a dominar melhor o material de aprendizagem. No processo de realização de trabalhos laboratoriais e experimentais, fórmulas, cálculos e provisões teóricas que pareciam incompreensíveis tornam-se bastante específicos. Ao mesmo tempo, são revelados muitos detalhes e fatos que os alunos antes não tinham ideia e, ao mesmo tempo, contribuem para a identificação e explicação de questões científicas complexas. Ressalta-se que, devido ao caráter investigativo do trabalho laboratorial e prático, os alunos os abordam com grande interesse, adquirem conhecimentos sólidos, convencem-se da confiabilidade dos conhecimentos recebidos e adquirem conhecimentos que têm poder de convencimento. Está provado que a eficácia deste tipo de trabalho pode ser aumentada através da disponibilização de cartões informativos. Estes incluem breves resumos teóricos que permitem aos alunos encontrar rapidamente as informações necessárias (no contexto das atividades de laboratório, isso pode incluir ajuda sobre funções específicas, fragmentos de algoritmos, espaços em branco de estrutura e modelos de programa) e estruturação clara do trabalho. Formalizar a abordagem e dividir o processo de solução em etapas claras e discretas possibilita a obtenção de resultados específicos de forma rápida e previsível. Além disso, ter essa estrutura torna mais fácil para os educadores monitorar e acompanhar o andamento de seu trabalho. Após um longo desenvolvimento, as aulas laboratoriais e práticas têm sido continuamente aprimoradas. Hoje, essa forma de organizar o processo educacional no ensino médio está se tornando um meio de formar futuros experimentalistas, que não apenas comprovam na prática a probabilidade de muitas hipóteses ousadas como também identificam novas formas de busca criativa. A eficiência desse tipo de trabalho pode ser melhorada fornecendo trabalho com cartões informativos. São breves resumos teóricos que permitem aos alunos encontrar rapidamente a informação de que necessitam (em termos de atividades laboratoriais, pode haver ajuda sobre funções específicas, fragmentos de algoritmos, espaços em branco de estrutura e modelos de programa) e estruturação clara do trabalho. Uma abordagem formalizada para a solução e a divisão do processo em etapas claras e discretas torna possível a obtenção de determinados resultados de forma rápida e previsível. Além disso, tal estrutura torna mais fácil para os educadores monitorar e acompanhar o andamento de seu trabalho.

Palavras-chave: Atividades laboratoriais. Integração. Métodos de ensino. Estágios. Ensino superior.

Introduction

Laboratory and practical classes play an important role in educating and upbringing future specialists for developing individual sectors of the national economy. Organized adequately from the beginning of the course, they not only help students master important sections of the theoretical course but also increase their interest in their chosen profession and accustom them to creative work, without which their production activities are unthinkable. Moreover, laboratory and practical classes combine theory and practice, demonstrating the transition from accumulated theoretical knowledge to practical skills and their application to solving applied problems. A specialist would only be successful in the workplace if they were familiar with the practice and needed to see how the theory is applied.

Laboratory and practical classes allow students to master valuable skills: use instruments and equipment, take measurements, design devices, create original installations and devices, develop new technology, etc. In addition, "laboratory literacy" is performed in the laboratory and in practical works. It consists of a deeper understanding of the significance of any research, experience, or experiment regarding nature or its phenomena.

Laboratory and practical activities play a significant role in the education of programmers and software developers. In higher education, the following laboratory and practical work types are important: illustrative and research. The first type of laboratory activity involves identifying a process according to a pre-proposed instruction and is primarily educational in nature. This type corresponds to the initial learning stages; such classes' main tasks are to master a particular programming language, get acquainted with an integrated development environment (IDE), and learn basic algorithmic structures.

Students get ready for laboratory activities during the time allotted for individual work. First, the student should understand the essence of the work, master the theoretical material, achieve a clear understanding of the work goals, and understand the final result. Then, the class involves the following stages: control of

students' readiness to perform a particular laboratory activity, the performance of specific tasks following the proposed topic: preparation of an individual report, and the evaluation of students' performance by the educator. Finally, the laboratory activity ends with preparing an individual presentation and its presentation to the lecturer. The final assessment is recorded in the laboratory work logbook and is considered when assigning a final semester evaluation for the course

This study investigates the specifics of laboratory practicums as the primary form of students' theoretical and methodological knowledge and practical skills integration.

The purpose of the academic paper is as follows. The formation of students' experimental skills and research skills in the process of performing frontal laboratory works is one of the main factors in implementing the State Standard of Higher Education. However, a successful solution to this issue is possible only if there is a clear organization of laboratory work and an effective methodology for conducting it. It is obvious that using an independent experiment is extremely useful for students, since it provides a systematic approach to implementing productive ways of cognition and forming the basis of learning activities in the process of performing frontal laboratory works. Thus, the main goal of the program is to prove that the development of laboratory skills will be facilitated by a new approach to organizing learning activities based on the simultaneous using of two textbooks: a textbook and a printed laboratory workbook.

Literature Review

The methodology of organizing and conducting laboratory works was the subject of debate both during the period of their introduction in the XIX century and each subsequent period of educational reform. Common issues in these discussions include as follows: the timing of laboratory work (before, during, and after studying the relevant theoretical material); the availability and content of instruction for them; the design and evaluation of the results of their performance. The purpose of

the discussions was to increase students' independence and develop their thinking abilities.

Using laboratory practicums to develop general learning skills in the educational process is a topic that has been discussed previously. We would also like to emphasize the tendency of oversaturation of such laboratory activities with mathematics and physics (formulas and laws that underlie the tasks to be solved with the program's help). On the one hand, there is a positive effect interdisciplinary connections, practical application, etc. On the other hand, however, this additional aspect often takes more attention and time than programming itself, and accordingly, the main task still needs to be achieved. Due to implementing the ideas of a competency-based approach in higher education, one of the leading learning process tasks is ensuring students have mastered key competencies. While describing the competency-based approach, scientists point out that to form a competent graduate in all areas of professional education and life, it is necessary to apply new teaching methods and technologies that develop students' cognitive, communicative, and personal activities. Since learning and cognitive activities are the leading ones in the learning process, researchers, when considering the composition of key competencies, put the student's competence in the field of independent cognitive activity at the forefront.

As a type of independent practical work, laboratory practicum intensifies the learning process, facilitates the perception of geometric concepts, and provides access to geometric facts that are constantly used in solving problems. Laboratory activities are essential in the educational process, as they allow the implementation of important didactic principles, such as the activity approach and humanization of the learning process. A student turns from an object of learning into a subject of their own activity. This subjective position is a typical feature of educational development.

Laboratory activities are covered in the studies of many educators and psychologists (Rezvan, 2012), (Harmatina, 2006), (Sazonenko, 2000), (Kurland, 2005), (Pyatnytska, 2003), (Ortynsky, 2009), (Nahayev, 2007), (Ligum, 2011),

(Lozova, 2006), (Kushnir, 2003). The analysis of historical and pedagogical literature convincingly proves that even in the early 60s of the XX century, generalizing publications began to appear. They in a certain way revealed aspects of the problem of scientific and research work, namely, they were focused on the following issues: organization of scientific and research activities, implementation of personnel work in scientific teams, financial support of science and scientific and research activities; the dynamics of human resources, forms and methods of training personnel for science, the philosophical aspect of using science as a form of cultural creativity are highlighted; conditions for successful organization of students' research activities; issues of the history of institutes and universities, their structure, training of scientific and pedagogical personnel, publishing, connection of education with industry, directions of theoretical and experimental research, their effectiveness; the integration of science and the educational and training process in educational institutions is revealed in scientific works (Auzina, 2002), (Berezivska, 2002), (Bondar, 1977), (Butenko, 2012), (Vitvitska, 2006), (Vlasenko, 2014), (Hudz, 2009), (Dychkivska, 2004), (Dudikova, 2012), (Kovalenko, 1996), (Kozak, 2014), (Kuzminsky, 2005), (Kushnir, 2012), Kurlyand, Z. N., Khmeliuk, R.I., Semenova, A.V. & et al. (2005). A characteristic result of these studies was the lack of convincing, universally recognized solutions to the controversial issues, which led to the resumption of these discussions.

Methodology

In the research, general scientific methods were used, namely comparative, analytical, inductive, deductive, and method of definitions. The research was carried out using a set of complementary methods that ensured the effectiveness and scientific reliability of the research results, namely: theoretical – analysis, systematization and comparison of the provisions of scientific and pedagogical literature to reveal the state of the problem under consideration, to clarify the essence of reflecting and implementing educational technologies in the educational

process; generalization and systematization – to substantiate the theoretical fundamentals of the research; pedagogical observation – to diagnose the level of future specialists' training after a series of activities on the example of analyzing the algorithm of laboratory works.

Results

Laboratory and practical work related to the elements of research and design is more in line with preparing students to apply knowledge in practice because they develop the ability to operate with knowledge, think logically, show creativity and assumptions, allow to identify and use auxiliary elements of knowledge in the form of supporting and cognitive visual signs and actions, and thus contribute to the formation of the necessary structure of knowledge and the ability to apply it. All this leads to the formation of such essential knowledge qualities in students as their depth and consciousness, efficacy and responsiveness, and mainly contributes to confidence building.

Such a format is more appropriate for senior students when they already have basic programming skills, and the goal is not to learn a language but, for example, to design software etc. For such projects, it can be effective to offer a teamwork approach. It involves sharing roles in the group, the designation of a "leader," and assigning tasks. This approach develops the skills of mastering a particular technology and teamwork organization, project management, identifying task stages, and controlling results.

Non-classical forms can also be used as separate episodic forms. An example is laboratory work such as "experiment". For example, a ready-made program code implements the same task using different approaches or algorithms, and it is necessary to study the efficiency in terms of execution time. This form is applicable when considering the topic of software product testing. The work can be diversified by adding a competitive nature, dividing students into several groups of "testers". The approach to conducting laboratory practicum as an experiment has been

introduced previously. It is widely used and offered in several methodological tools. Regardless of the laboratory class form, students should remember that most laboratory work time is allocated to the experiment, not the colloquium. Students are usually quizzed at their workplace. The lecturer gives explanations during the work that deepen the understanding of the experiment. Self-control, patience, and fairness are the qualities of teaching that contribute to the successful education of the subject and the successful learning of the content by students.

The essence and importance of laboratory research are based on the fact that quantitative characteristics bring laboratory research to a higher level, making it closer to scientific work, which uses statistical methods to process the results and draw appropriate conclusions.

Laboratory and practical activities should have been given more attention for a long time. As a rule, they were and still need to be performed systematically, from time to time, only by some educators. The reason for this is the underestimation of such work. Currently, interest in such forms of learning as laboratory practicum is reviving again. One of the ways to improve the education system is to organize specialized training. In developing a model of mathematics education in the context of profile differentiation, the following areas of specialization were taken as a basis: humanitarian, application-oriented, and natural sciences. Given society's great need for qualified personnel to create and implement new technologies, special attention should be paid to the applied area, focused on using mathematics in engineering, manufacturing, economics, and natural sciences (On Approval of Higher Education Standard for Specialty 091 "Biology" for the Second (Master's) Level of Higher Education: Order of the Ministry of Education and Science of Ukraine dated November 21, 2019. No. 1457. URL: https://mon.gov.ua/storage/app/media/vishcha-osvita/zatverdzeni%20standarty/2019/11/22/2019-11-22-091-M.pdf.).

Laboratory class is a practical training conducted individually and with a subgroup of students. The purpose of the class is to implement the following main functions:

- to master the system of means and methods of experimental and practical research;
- to develop students' creative research skills;
- to expand the possibilities of using theoretical knowledge to solve practical problems.

Thus, based on the fundamental principles of forming students' research activities, the priority goal of education is continuous self-development. Therefore, during the learning process, it is necessary to develop research skills for the constant progressive development of students. Furthermore, research activity aims to develop students' creative thinking and is an integral part of their creative activity.

As a type of independent practical work, laboratory practicum activates the learning process, facilitates the perception of geometric concepts, and provides access to geometric facts that are constantly used in solving problems.

Laboratory and practical works are classified based on various grounds. The assignments can be performed both in the classroom and as part of homework (training exercises), both under the guidance and with the direct assistance of an educator, independently (students are allowed to use textbooks and reference books), and sometimes with complete independence (test laboratory work). All types of laboratory practicums are advisable to conduct (Bondar, A. D. & Rans'ka, L. A., 1977).

As another type of laboratory practicum in the last century's methodological works of the 60s and 70s, laboratory and graphic works are considered another type of laboratory activity. Laboratory and graphic works are a type of students' educational activity under the guidance of an educator, whereby geometry is studied by designing and building geometric figures through the academic, theoretical, and practical research of the formed figures and their correlations (Bondar, A. D. & Rans'ka, L. A., 1977).

All laboratory practicums can also be divided by the type of tools used in the classroom:

- laboratory works on teaching the use of drawing and measuring tools;
- for designing;
- for calculations;
- for construction;
- with the use of ICT.

Practical laboratory works aim to develop student's skills in applying the acquired knowledge to solve specific practical problems. The plan for the applied laboratory activity has the following format:

1) in a conversation, the educator repeats the mathematical facts that will be required in the laboratory work;
2) each student performs the work independently; the educator assists and corrects the work if necessary;
3) the educator summarizes the results; they should have an evaluative purpose.

Currently, methodologists distinguish the following types of laboratory practicums:

- laboratory work that serves to establish a particular fact or situation. As a result of the work done, student's express hypotheses and assumptions, which are subsequently verified;
- laboratory work that leads the student to establish a particular relationship between the values of a mathematical fact that requires rigorous proof;
- laboratory work that contains elements of a research type or is aimed at solving a specific practical task;
- laboratory work aimed at confirming the accuracy of the formula found, the theorem proved on specific examples, and developing solid skills in calculations, designs, etc.

With a competent classroom organization, students are gradually mastering the techniques of academic activity and are fully aware of the purpose and features of their use. Subsequently, students apply them independently to reveal new

knowledge, one of the main criteria for a person's mental development advancement. Laboratory activity is a valuable means of fostering mental activity. It activates mental processes and arouses keen interest in the cognitive process. As a result, students willingly overcome significant difficulties, train their strengths, and develop abilities and skills. In addition, it helps to make any educational material exciting and facilitates the learning process. There are several ways to define the concept of laboratory practicum:

Laboratory classes are one of the types of independent practical work in higher, secondary specialized, and general education schools. They aim to deepen and consolidate theoretical knowledge and develop independent experimentation skills. They include preparing the necessary instruments, equipment, reagents, etc., for the experience (experiment), drawing up a schematic plan for the experience, conducting it, and describing it. They are widely used when teaching natural and technical disciplines. The most rational ratio between the theoretical course and laboratory classes is established for each field.

Laboratory activities are an independent solution of tasks, the conditions of which are set by specific technical details, various objects or specially made models, drawings, functions on a tabletop, etc., to achieve specific educational goals, in particular, to develop the ability to apply the knowledge gained in practice.

Laboratory practice is a teaching method when students, under the educator's supervision and according to a previously planned curriculum, conduct experiments or perform specific practical tasks. While doing so, they perceive and comprehend new educational material and consolidate previously acquired knowledge.

Based on the definitions, laboratory practicum can be a method, form, and means of learning. People often confuse laboratory and practical work, believing they are the same thing. Practical activities are independent work to verify theoretical facts, ratios, and dependencies in a particular case of applying theoretical knowledge in practice, solving practical problems, etc.

It is essential to understand that laboratory studies do not replace practical classes. On the contrary, laboratory studies are excellent preparation for the latter. The laboratory activities are a necessary preparatory stage for practical work. While comparing laboratory and practical activities in terms of the learning process, it is important to note the advantages of the former over the latter:

1) laboratory work is easier to perform practically (in class);
2) laboratory work allows students to understand the topic more deeply and to consolidate their skills in measuring the values of the studied quantities required to solve the task;
3) in general, it takes less time to perform laboratory work than to perform practical work;
4) conducting laboratory work before practical ones helps to realize which mathematical theory to apply when solving practical problems;
5) during laboratory work, it is easier to organize the individual progress of all students.

Obviously, using laboratory and practical activities in the classroom will increase students' interest and engagement. Laboratory practicums play a role not only in achieving educational goals but also in achieving educational and developmental ones. Each student learns to apply the knowledge acquired, perform the necessary tasks independently, take responsibility for the work performed, and master certain aspects of the topic under study.

The use of laboratory activities in education is aimed at achieving the following goals:

- educational: mastering mathematical knowledge and developing practical skills; learning the operating principles and skills of using various calculation, measuring, and drawing tools; improving students' knowledge and teaching them to apply this knowledge independently; teaching them to solve practice-oriented problems;
- educational: formation of accuracy and responsibility for their activities, intensification of research activities, formation of teamwork skills;

- developmental: observation development, ability to put forward and validate hypotheses and assumptions, refute false conclusions and judgments, developing an interest in the subject (On Approval of Higher Education Standard for Specialty 091 "Biology" for the First (Bachelor's) Level of Higher Education: Order of the Ministry of Education and Science of Ukraine dated November 21, 2019. No. 1457. URL: https://mon.gov.ua/storage/app/media/vishcha-osvita/zatverdzeni%20standarty/2019/11/22/2019-11-22-091-B.pdf.)

Using laboratory work in the classroom and systematic inclusion in students' learning activities ensure that students master the basic concepts much more, allowing for better student performance and improving the knowledge quality, thus creating an excellent learning base.

Let's consider a specific example (Rzhepetskyi V. P. Laboratory works in the course of general physics for students of technological specialties: [methodical recommendations] / V. P. Rzhepetskyi, M. A. Sliusarenko - Kryvyi Rih: Publishing department of KPI of the State Higher Educational Institution "KNU", 2014. - Part 1. - 64 p.). The textbooks should provide more detailed instructions for such works, allowing students, with the permission of the teacher, to refer to it in case of difficulties in conducting the experiment. The laboratory workbooks contain the following information:

- Laboratory work №;
- Name of the laboratory work;
- Tasks;
- Equipment;
- Measuring device;
- Unit of measurement;
- Division point;
- Limits of measurement by the instrument;
- Measurement results;
- Conclusion.

In the case of laboratory works on electricity, after the specifications of the measuring device, it is indicated as follows.

The electrical circuit of the experiment. As one can see, the workbook contains the task, not the purpose of the work. The task is similar to a problem, that is, it contains a condition that helps students plan an experiment. For instance, in the example of the laboratory work given above, the task is as follows: to assemble a sequential circuit from the elements specified in the equipment; to measure the current in three different parts of the circuit; to find out the correlation between the measurement results. The workbook contains a task and a list of instruments and materials. All other elements of the instruction are completed in writing by students. As one can see, the workbook contains a scheme of the report for the work, which also defines the logic of conducting the experiment. The first laboratory work of this group involves the teacher's explanation of the procedure for performing the work and preparing a report for it. Due to the scientific article's limited space, we don't discuss instances of instructions for other types of laboratory work, but we do suggest strategies to raise the importance of these tasks in the development of experimental skills.

Laboratory works on measuring physical quantities (density of solids, specific heat capacity, etc.) are aimed at further development of experimental skills and consolidation of the introduced concept of a physical quantity. These laboratory works are performed by students of junior courses. Laboratory works are carried out after the introduction of a physical quantity; consequently, students already know the formula from which this physical quantity can be found and have performed the first steps to calculate it. Students must solve a problem at home that actually reflects the logic of the laboratory work. Students are able to use the necessary measuring instruments. In a given group of laboratory works, students are expected to perform the following system of mental actions:

1) choose a formula from which to find the value of the physical quantity specified in the assignment for the laboratory work;

2) find out which physical quantities included in the formula should be measured and which should be found in reference tables;
3) find out what measuring instruments and materials will be needed;
4) determine the scheme of the experiment;
5) make a table of data obtained by measurement from reference tables, calculations.

In the first laboratory activity of this group, the teacher explains the following system of reasoning and the corresponding reporting scheme.

The laboratory workbooks contain the following information:

- Laboratory work №;
- Name of the laboratory work;
- Tasks;
- The reference formula;
- Physical quantities to be measured;
- Calculations;
- Diagram or drawing of the experimental setup;
- Table of calculation and measurement results;
- Calculation of tolerances;
- Conclusion: (Posibnyk do laboratornykh zaniat iz kursu «Zahalna tsytolohiia i histolohiia» [Manual for laboratory classes for the course «General cytology and histology»] / compiled by: Dzerzhinsky, M. E., Harmatina, S. M. & Danilova, O. V. Kyiv: Phytosociocenter, 2006, 259 p.)

All elements of this instruction, except for the task, are completed by students. Detailed instructions in the textbook are provided by the presence of formulas, equipment, installation diagrams, and tables for entering numerical values of quantities. The new program stipulates that a group of laboratory works on observing physical phenomena and processes (magnetic field effect on current, Brownian motion, interference and diffraction of light, continuous and linear spectra) are performed by students of junior courses. When drafting instructions for them, it is advisable to proceed from as follows: if these laboratory works are

performed after studying the phenomenon, when the relevant essential features of the phenomenon are revealed through demonstration experiments, explained by the teacher, then, firstly, they no longer arouse students' interest, and secondly, the experiments performed are not aimed at forming the ability to observe, developing students' activity and independence. The students already know the result; therefore, the report for the work will describe it correctly, regardless of whether the students have seen this result or not. In the case of conducting laboratory work prior to studying the relevant educational material, students need a detailed description of what to do and how to do it. Teachers' assistance plays an essential role in this case. Special equipment is used in the works of this group, which does not provide for the development of students' skills in using it. The primary objective of the experiment is to develop the ability to observe, identify the object of observation, establish the characteristic features of the phenomenon and process, and highlight their essential features. Therefore, it is possible to preserve the nature of the instructions for these laboratory works that are in the textbook and workbooks on a printed basis.

Laboratory works, the purpose of which is to clarify regularities and establish laws (conditions of equilibrium of a lever, the law of conservation of energy, Ohm's law, Newton's second law, the law of conservation of momentum) are actually related to the experimental verification of formulas known to students. Therefore, the laboratory works of this group are similar to the group of works on measuring physical quantities. However, it is possible to conduct some of them prior to studying the material, i.e., in the same way as when studying physical phenomena.

Laboratory works, in which students have to assemble simple technical devices and models, require students to be familiar with these objects of activity. The value of such works lies in understanding the connections between individual elements of the devices, and understanding their principle of operation. Therefore, it is advisable to depict only the elements of these devices in the laboratory workbooks, and indicate in the assignment that they should be assembled independently and demonstrate the operation of the assembled device to the

teacher. A drawing of the assembled device is provided in the textbook, in the instructions for the laboratory work. The program includes another group of laboratory works studying the characteristics of devices: semiconductor transistor and diode, diffraction grating, lenses. These works require a description of the system of actions for both planning and conducting the research and documenting the results.

Conclusions

Laboratory classes help students to absorb the educational content better. While performing laboratory and practical activities, formulas, calculations, and theoretical statements that seemed incomprehensible became quite concrete. At the same time, many details and facts are revealed about which students had no idea before; meanwhile, they help identify and explain complex scientific issues. Thanks to the research nature of laboratory and practical classes, students approach them with great interest, acquire solid knowledge, are convinced in the reliability of the knowledge they have received, and acquire conviction-based knowledge. The efficiency of this type of work can be improved by:

- providing work with informative cards. These are short theoretical summaries that allow students to quickly find the information they need (in terms of laboratory activities, there may be help on specific functions, algorithm fragments, structure blanks, and program templates);
- clear structuring of the work. A formalized approach to the solution and the process breakdown into clear, discrete steps makes obtaining certain results quickly and predictably possible. In addition, such a structure makes it easier for educators to monitor and track the progress of their work.

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