LABORATORY PRACTICE IN PHYSICS AT UNIVERSITY AS A FORM OF TEACHING

Julia Ilcheva

University of Mining and Geology "Sv. Ivan Rilski" Sofia 1700, Bulgaria E-mail: <u>Julia1@need. bg</u>

ABSTRACT

It is essential to define the process of teaching as completely different from the process of studying, i.e. the latter narrows the meaning of the teaching process by making it equal only to the work of the student.

The basic importance of the experiment in teaching Physics originates from the specifics of the subject itself. There are two methods of learning in Physics- theoretical and the other is based on experiments- unity and cooperating. That's why the usage of experiments in the teaching process is related to the role of experimenting in the Physics as science and its specific functions that experiments could have in the process of learning.

Laboratory practice in Physics at University as a form of teaching is a way of expression, structure, and organization, clarifying and stabilizing the content of the process of teaching.

. Here we discuss the physics experiment from a methodological point of view .

We answer the question:" Why the practices are so important?

Different ways of carrying laboratory practices in Physics are given, depending on the type of university; we've included The University of Mining and Geology "St.Ivan Rilski". Problems, related to organization and schedule are also discussed. Some answers for these problems have been proposed and I believe they will contribute to improvement in the efficiency of teaching Physics. Efficiency requires ability to study of the origin of problems and their solving through experiments, as well as establishment of long-lasting capability of critical estimation of different situations in the surrounding world and adopting of ways for optimizing of processes that exist in this world.

In the didactical literature a lot of, sometimes confusing definitions of the meaning of teaching can be observed. This fact is somehow understandable, i.e. teaching, according to M.Schiro (Andreev, 1996) has many dimensions, and that's why it is discussed as: internal part of the subject, a function of this subject, way of didactical teaching, medium between the content of the subject and the student, and academic discipline. As a whole teaching can be described as relatively independent unity between teaching and students' work, called studying. That's why the process of teaching is different than the process of studying, i.e. the latter narrows the meaning of the teaching process by making it equal only to the work of the student.

The process of teaching is a process of cooperating between the teacher and the student, during which knowledge, skills, habits and competence are obtained. The correct organization could be of basic importance to making it more efficient. We describe "organization" as a way of combining parts in unity, so the organizational types of teaching are extremely important.

The organizational forms of teaching are an important didactical category, because they give the teaching process structure and content. However, didactical and teaching publications do not give a commonly accepted definition. The word "form" originates from the Greek "formal", which means structure. According to Spored PI. Radev (1996), organizational form of teaching is " a way of expressing, structure, organizing and stabilizing the teaching process. Given the fact that we have to make different between the two basic didactical categories- forms of teaching and methods of

teaching, as well as clarifying term logical difficulties, many teachers and pedagogues (Petrov,1994) accept a new definition of the forms of teaching. They think that the organizational forms of teaching should be discussed as a relatively independent element that includes purpose, content, methods, mediums, number of students, place of teaching, time, circumstances, and so on, as well as the connection among all these parts.

Laboratory practice in Physics at University could be described as an organizational form for practical teaching. It, according to I.M.Cheredov (1988), is a form of organization, which requires all the elements of the system to be in a particular order and place, and in the same time establishes connection among these elements (parts) of the whole (subject) and their functions and cooperativeness.

Physics practice has first been established in Universities, and after that in High Schools (Kiuldzhieva, 1997). It is part of the system of Physics experimenting, which also includes: demonstrations, experiments and laboratory practice.

The basic importance of the experiment in teaching Physics originates from the specifics of the subject itself. There are two methods of learning in Physics- theoretical and the other is based on experiments- unity and cooperating. That's why using physic experiments in the process of teaching is related to the importance of experimenting for the subject itself and to its specific functions.

The words of D.I.Mendeleev that science exists where there is measurement, are incredibly famous (Bespalko, 1982 i

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Agapov, 1982). Measuring is the basic of experimenting. Without them it is impossible to study different processes or in another word- there is no Physics without experiments. The words of St. Lafchiev (1896), said almost 100 years ago support that:" According to pedagogic, Physics as a science should be taught through experiments, carried right in front of the students, and the lesson itself should start with the experiment. The experiment should be simple, it should show only the processes one wants to discuss. The experiment should be performed with the greatest punctuality and clarity, so the student can understand the difference between the cause and the result and the connection between them. When the students get the point of the experiment, the physic law should be discussed." These words describe demonstrations, which are important not only in high schools, but even later in the studying process- Universities. The material from the seminars should be completely and thoroughly understood and the students should be informed, so all this information can be transformed into knowledge and competence of the graduate student.

The practical seminars are also extremely important, because they contribute to the process of students becoming skillful and intelligent scientists, who are capable of using scientific approach towards solving of different situations independently.

V. P. Bespalko (1982) suggests that we should reconsider the basic idea of the personality of the professional – "accumulator of information". We should adopt a contemporary point of view: the professional is a "provider of the correct and useful information", i.e he is the person who is able to collect, organize and use the information in his work. Such skills could be obtained in every form of education, besides lection.

One of the most frightful experiences of first year students (Giurova i dr., 1997) is offered by department of Physics, where teaching is maintained mainly by practical experiments.

In some American Universities, as well as in Bulgaria, influenced by the former Soviet Union, the basic purpose of the laboratory practices is:" to help students understand the material by practicing" (Lazarov, 1995). However, there is a big group of western scientists that does not accept that main purpose, basically because of the lack of time and money. That is adopted by some of our famous lectors (Lazarov, 1995), who stand for independence of the physics practical experiments, i.e. practice should independent from the lections. Undoubtedly this contemporary theory could bring engineers, type "r"(according to the modern concepts of engineering profession and education, regarding the functions in practice)- participants in research projects, innovative laboratories and departments, i.e. research engineers. It is well known that the students in western countries are allowed to work in modern laboratories. They are provided with apparatuses allowing research in corresponding fields of modern Physics. The tendency last 2 decades is more and more computers to be used for studying the data, statistical analysis, i.e showing the results- Computational Physics. This kind of Physics allows the usage of modern computer and forecasting methods, which can be done without real experiment, and are based on theory. Theory explains the problems and gives formulas, which can be used for forecasting the outcome of every experiment. An example of such formula is the equation of Shr*odinger.

Most Technical Universities experimenting related to a research problem that meets the requirements of nowadays is difficult, because of the old technical base and decreased number of lections for the engineers, according to the latest requirements of The Educational Ministry.

A possible way of solving this problem is proposed by Lazarov (1995). Another approach that can be used is Computation Physics, which allows experimenting with multiple variables, in order to optimize the theory for a given experiment. The experience of many researchers has proved that the quantity results give new ideas.

According to doc. d-r Lilkov i doc. d-r Dzherahov's proposal, the department of Ph7ysics is to offer the students computerized class in Physics.

The tradition in most Technical Universities is to make a cycle of three or more laboratory practices with the same thematic. For example the students at The University if Mining and Geology will have the following cycle of laboratory practices in unit "Mechanics":

Practice#1: Defining the module of linear deformation as a result of stretching

Practice#2: Defining the module of degree deformation

Practice#3: Experimenting with the laws of circling movement with the help of <u>mOberbeck's pendulu</u>

Practice#4: Definition of the momentum of an object with random shape, using the help of torsion pendulum

Academic time should support the particular practice tasks so students are introduced to the laboratory material. As general the academic time should: clarify the problems set by the laboratory practice; instruct students about safety and fire danger when working in the laboratories of department of Physics; requirements that students should fulfill when preparing their papers and protocols; facts about measurements and few little experiments striking on the mathematics of the research results and the way they should be conveyed; discussing the measurement apparatus and how it influences the results.

Students need to have obtained specific minimum of knowledge from high school about Physics laws and terms, elementary mathematics (algebra, geometry and trigonometry), as well as capability of punctually processing the practice, finding mistakes, correcting them (because the final purpose of a measurement is obtaining true value of the measured variable), and preparing protocols, in order to successfully participate in laboratory practice.

This minimum knowledge would also make it easier for students to meet basic requirements, solve problems in Physics practice, which is related to the fact that Physics is science based on experiments, and practice is an essential part of the studying process.

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Basic purposes of laboratory practice in Physics are:

- Opportunity for the students to observe basic Physics experiments, which allows students to obtain an important skill –Intuition for Physics (ability to think abstractly)
- Showing students basic measurement apparatus (equipment and measurements that are used in experiments). Knowledge of the mechanics of equipment, principle of work and what can be obtained, is a necessary part of studying process. The character and complexity of the equipment are related to the method, used to convey the experiment, as well as to the dimensions of the measured variable.
- 3. Teaching different methods of ordering the measurements and techniques of experiments. Ability to choose among different tools is necessary, so the experiment could be conveyed with punctuality, the mistakes could be measured and the final result could lead to right conclusions.

Regular practice will help proving the assumption that Physics is punctual science. This is necessary because many students do not think so. To some extent they are right, because in many cases the results are not absolutely correct. Particular attention should be paid to evaluating the systematic mistakes in all units and to the necessity of thorough analysis of the conditions under which the experiment is conveyed.

The difficulties with solving Physics problems originate from inadequate knowledge of students from high school. A survey conveyed by the Department of Physics at Technical University-Sofia in the beginning of school years 1996-1997 and 1997-1998, shows that 80% of students in their first year in university are not prepared and do not know the basics of Physics. According to lectors S. Nikolov and St. Nicolov at Technical University-Sofia (2001) this fact is due not only to the system of high school but also to the criteria of accepting students to university. The lectors have the following propositions:1) exam in Physics, analogical to this in Math- the applicants has the right to choose between the two exams or they take both of then, and they can choose to have the better grade;2) exam in Physics for those students who had less than 300 classes in Physics in high school

That's how time at university will not be used for catching up with missed material in high school and using the knowledge of the student he/she will be introduced to the university classes and laboratory practices in particular.

As far as Laboratory practice, an answer to the problem is proposed by teachers in Physics at "Angel Kynchev" University in Ruse (Angelova, 1995). After unsuccessful practices in cycles during 1990 – 91, 1991 – 92 and 1992 – 93 they changed the system of conveying the practices, i.e. they started using frontal method. That was related not only to the abilities of students, but also to inconsequence in the lecture material as well as in the structure if practices themselves. Here is an example of a cycle "Molecular Physics and thermodynamics":

Practice#1: Measurement of temperature

Practice #2: Defining coefficients of linear thermodynamic change in length and volume in metals

Practice#3: Experimental defining of metals' coefficient of heat conductivity

Practice shows that during such cycle 2/3 of the students will work in a different sequence- first they will participate in Practice #3, and after that they will study the basic variable "temperature", its dimensions and ways of measuring it.

We need to point out that in most of the laboratory books do not include practice for temperature measurement, but only practices #2 and #3. That's the case because of the assumption that students have knowledge from high school about such an important variable as temperature. Unfortunately textbooks from 8th grade do not include practicing temperature measurement, although Physics is thought from 7th grade. There is a material about temperature in 6th grade "Nature science" textbooks, requiring practical measurement, but is unlikely students to remember this through the following years.

The advantage of frontal laboratory practice is the opportunity it gives to the future to explain the material to all the students in the little time he has. However, the disadvantages are many more. First of all it does not encourage independence and creativity of the student-responsibility for his/her own work, inner desire for more and more knowledge.

At University if Mining and Geology "St. Ivan Rilski", as mentioned before, teachers use a cycle of laboratory practices to teach in laboratories. A basic requirement is students to prepare themselves before the practice using the material from lectures. This includes:

1) thorough studying of the theoretical base of a particular practice, problems and basic questions, as well as understanding of the experiment and the requirements for conveying it. It is recommended the teacher to give a list of literature related to the practice, so the students could use it during the laboratory practice to help themselves. 2) preparing of a protocol- schemes, tables, estimations and so on, in correspondence with the requirements and context of the protocol.

If this preliminary preparation is not done, it is not recommended students to go on with the experiment itself, because they will not be absolutely sure about their work, they'll waste time and make a lot of mistakes.

The requirement students to work independently, by themselves is not related only to the preliminary preparation, but also to the experiment and protocols.

The laboratory practices at University of Mining and Geology also include tests(4 types for 1 cycle) on the material of several cycles, prepared by Iul. Ilcheva and P. Galanov (2002).

The grade of the students is related to : preliminary preparation of the student; experiment work; usage of technical tools in the

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process of the practice; prepared protocols, and different didactical tests.

The didactical tests can be used as a signal tool for the teacher and the students themselves to evaluate their ability and the progress they make. The opportunity to coordinate their studying process before the final exam, gives the students a chance to prepare themselves better and feel self-confident.

The organizational forms of education are an important part f the pedagogical process at University.

To understand the importance of laboratory practice in the process of teaching Physics (which is only part of the broader discipline "Simpologia") it is enough to point out the nine specific units of the science and most importantly "the process of measurement." The broad meaning of the word "measurement" is relating in objective reality in order to penetrate in it, which is the basics of Physics itself and is important to creating an experimental culture, essential for future professionals.

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