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## PRINCIPLES OF CONSTRUCTION OF A LABORATORY PRACTICAL WORK FOR UNIVERSITY STUDENTS

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### **Abstract.**

*On an example of the inorganic chemistry course at the Belarusian state university main principles of construction of a laboratory practical work (integrity of a course; gradualness of development of skills of students; applied character and an ecological orientation of works) and the requirements showed to separate laboratory work are considered.*

The important components of the organization of studying of the chemistry are laboratory works. For example according to curricula of chemistry faculty at the Belarusian state university (BSU) to laboratory researches on profile chemical disciplines are removed up to half hours from the common budget loadings. This tendency is traced in the foreign higher school too (Kepl 1990). During active independent practical activities of students there is a fixing, expansion and a deepening of the knowledge received at lectures and seminar employment.

The analysis of the methodical literature allows it is possible to allocate some directions of the organization of laboratory researches in chemistry in high school. One of these directions is consideration a practical work as the illustrative appendix to the lecture course, serving as means of a practical deepening of theoretical knowledge. Frequently there is a question on where it is necessary to acquaint the student with a new material: at lecture or at laboratory work? In works (Sokolovskaja 1979, Ahmetov 1986) such sequence of kinds of employment when laboratory research on the certain theme precedes lecture on same theme is offered. It is supposed,

that the laboratory practical work in that case gets function of preliminary preparation of students to the decision of problem tasks. Lectures at this approach the role of logic generalization and expansion of a material with which the student has got acquainted on laboratory researches and by preparation for them. There are opinions that the laboratory practical work should be not necessarily adhered to a theoretical rate, and may have independent tasks (Rao 1978, Pickering 1985). In the some higher school the approach at which realization laboratory work follows lecture on the given theme is more widespread. So according to work (The chemical education group 1997) in 69 % of the American universities laboratory work on chemistry is preceded with lecture, and only in 6 % consideration of a new theme begins on a laboratory practical work.

The second direction in the organization of laboratory practical works is connected to introduction of elements of the teaching-and-research principle, with the planned tendency of transformation of studies in research (Sviridov 1998, Karataeva 2003, Hugerat 2004). The key moment of such employment is familiarizing students with reception of new knowledge by the active independent work demanding of them not only intellectual efforts, but also elements of creativity.

And at last, the third direction is connected to development at students of receptions and ways of obtaining knowledge, formation of the qualities necessary in the subsequent professional work. Formation of practical skills of students on the chemical department of BSU in a practical work in

inorganic chemistry (Sviridov 2000, 2003) provides acquaintance to the equipment, devices and the materials used in a practical work, development of skills of experimental work in chemical laboratory, performance of calculations, the decision of problems, acquaintance to techniques of processing and representation of results of experiment. The practical work will be carried out in the form of works on synthesis of substances with definition of an exit of a product and the subsequent studying of its chemical properties. During a practical work students carry out synthesis of inorganic substances at different temperature, in water and not water solutions, in a solid phase, on air and in an inert atmosphere. Thus they acquire: experimental skills of work with substances (reception, clearing, storage, weighing, measurement of volume), chemical utensils and devices (microscopes, pH-meters, high-temperature furnaces and other); skills of assembly of simple devices; techniques of preparation of solutions and solid mixes with the certain contents of components, heating and cooling of substance and solutions; bases of research of chemical properties of substances (qualitative chemical reactions, definition of temperatures of fusion and decomposition of substances).

The major principles which were used at construction of a laboratory practical work in inorganic chemistry at chemical faculty BSU are: integrity of a course; gradualness of development of skills of students; applied character and an ecological orientation of works.

*Integrity* means conformity of laboratory works to a course of lectures when each theme of a lecture rate receives the development at performance of laboratory researches. Activity of students thus gets cognitive character; they receive an opportunity to observe the chemical phenomena to be convinced of practical applicability of chemical laws. However performance of a practical work is not reduced only to an illustration of a lecture course, and pursues also own tasks: acquaintance with a technique of chemical experiment and with chemical substances, development of the basic types of calculations in chemistry, acquaintance with inorganic synthesis.

The following principle of the organization of a laboratory practical work assumes *gradual development* of skills of practical work of students in laboratories. All laboratory works at the initial stage of a practical work for students at the chemical department of BSU are divided into two groups conditionally. Prime works are aimed at development of methods of realization of chemical experiment with beforehand known result. So, for example, at development of methods of clearing of substances each student should perform works on clearing solid bodies by methods of recrystallizations and sublimations, clearing of a liquid, on reception and clearing of gas. Thus statement of work at the most different level is possible: from simple following to the described techniques, but with other substance and other initial data, that quite on forces to any student, before development of a technique of performance of work with attraction of data from the literature. The special attention in this works is given observance of requirements of the safety precautions, technique of realization of experiment, performance of calculations. The sequence of performance of works is determined by the teacher in view of preparation of the student and a structure of their future work (the teacher of chemistry, the chemist - researcher, the chemist - ecologist etc.). A plenty of techniques of synthesis of one level of complexity there suffices allows to make for each student the individual plan of performance of a practical work.

Works as a result of which the student receives subjectively new data concern to the second group. In this case the main tasks put a substantiation of a used technique, supervision over the phenomena occurring during experiment and their explanation, a substantiation of conclusions from the carried out work and their fixation in the accepted form of the accounting document. As has shown our experience, interest in students is caused with preparation of a technique of laboratory work on the basis of results of the scientific researches published in a press.

*Applied character* and a professional orientation of a laboratory practical works at the course of chemistry are a basis in stimulation of interest of students to theirs performance. So, for example, in a practical work in inorganic chemistry for students of pedagogical branch of chemical faculty BSU are included synthesis substances which properties is studied in the school program. Performance of such works is accompanied by realization of demonstration experiment. By preparation of the students specializing in the field of chemistry of medicinal connections and chemical ecology in a laboratory practical work in inorganic chemistry are included the additional tasks connected, for example, with clearing of utensils, by preparation of solutions, use of not water solvents etc. (Sviridov 2003).

In modern conditions *the ecological orientation* of a laboratory practical work in chemistry has the important value. At laboratory works most conveniently to examine the environmental problems connected to use of

concrete substances, observance of safety precautions regulations at work in laboratory. It is possible to do it within the framework of existing works, without radical reorganization of a practical work. Ecological component in a practical work for students of some specialties it may be considered and as an element of formation of professional skills.

Preceding from the general principles of construction of a course of a chemical practical work it is possible to formulate **the basic requirements showed to concrete laboratory work:**

- The precise *formulation of the task* subject to the decision. In the formulation requirements to those skills which are necessary for getting during performance of the given work should be necessarily reflected;
- *Creative character*. To give to work creative character it is possible by statement of some questions, for example: "Why such initial components are used?", "Can you to replace in synthesis initial substance C with substance D?", "Why synthesis is necessary for carrying out in the alkaline environment?", "What factors define cleanliness of the received product?" etc. Answers to similar questions after performance of work demand creative judgement of all course of work, realization of the additional experiences planned by the student already independently, search of the necessary information in the literature and electronic databases. Interesting methodical reception for realization of the creative approach at performance of laboratory works is a modification of standard techniques;
- *Use of substances* which properties to the students are known even theoretically or concerning which properties in the literature there are full enough data;
- *Selection of works* which purpose is not only supervision and the description of spillovers, but also realization of measurements and calculations, processing of experimental results. Thus work should acquaint with new for the given student utensils, the equipment or a new method of measurement of any new characteristic;
- *A high technological level of the labware*. The given requirement not always is easy for executing in practice; however whenever possible students should know about the modern equipment used in chemical laboratories. At use of devices it is necessary to acquaint students with their principle of work briefly;
- *Simplicity, reproducibility and evident character of carried out experiences*. It is necessary to avoid or reduce to a minimum unproductive operations and use of the complex equipment that the attention of students was not abstract from direct supervision over the chemical phenomenon. For first-year students the prospect of fast reception of results, and also their reproducibility at recurrence of experiment are important;
- *Observance of a principle of consecutive complication of works*. For example, the description of tasks in a practical work in inorganic chemistry for students at the chemical department of BSU (Sviridov 2000) is methodically constructed so, that in the beginning are instructed in detail enough regulating actions of students, and later the description of work set only a general plan of synthesis, which detailed elaboration (a choice of reactants, utensils, conditions and a technique of realization of separate operations etc.) the student carries out independently. It corresponds to practice in others highest schools (Hanson 1982) and allows to make individual sets of works in the certain sequence of their plans for each of students in view of similarity of works on operations, a reasonable sequence of development of techniques of a laboratory practical work;
- Questions of the *safety* precautions at realization of laboratory works in a student's practical work should have priority value. Whenever possible it is necessary to remove the toxic and caustic substances, dangerous technological operations from a laboratory practical work. It is necessary to pay attention students to inadmissibility of hit of toxic connections in the city water drain;
- *The cost price of work*. The problem of high cost of laboratory works on chemistry is actually for different educational institutions (Srivastava 1985). It is necessary to exclude expensive and remote reactants from a laboratory practical work the part of works can be carried out by micro-method experiments ore by virtual experiments. The opportunity's price reduction a laboratory practical work by replacement of traditional chemical experiment with computer imitations are observed in (Butler 1979, Orlik 2002, Amrani 2005), but this problem demands special discussion by consideration of preparation of professionals (Dubravac 1979, Bourgue 1987).

In summary it would be desirable to emphasize, that considered principles of the organization of a practical work and the requirements showed to the contents of laboratory works, may be realized at studying any discipline of a chemical cycle.

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