To the Question of Improving the Quality of Teaching "Chemistry" for Students of Engineering Specialties

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ABSTRACT

Abstract. The article emphasizes that oil and gas production is directly related to the study of complex not only physical, but chemical processes, therefore, special attention should be paid to teaching chemical disciplines in an oil and gas university. The author deals with an analysis of the curriculum for the discipline for 2012 and 2019 academic years. Recommendations were given for optimizing the educational process in the discipline "Chemistry" on the basis of a comparative analysis. The teaching method used by the author, the use of logical schemes, made it possible to study the subject through a dialogue with a computer and a lecture, accelerate the mastery of professional skills by students, individualize training and significantly save the teacher's time spent on monitoring the student's work. The means of implementing this technique and training was the support system for the educational process in Industrial University of Tyumen.

Keywords: chemistry, educational process, curriculum, diagram, structure.

Introduction

Special attention should be paid to the teaching of chemical disciplines in an oil and gas university. It is also necessary to take into account that oil and gas production is directly related to the study of complex not only physical, but chemical processes.

Technological progress has led in recent years to a significant increase in the number of materials used and the variety of their properties in the oil and gas industry. The development of new materials, the introduction and development of new technologies also require the introduction of a new concept of teaching the disciplines of the chemical cycle for students of engineering specialties at the university.

The command of the time indicates the need to reconstruct education at a university, taking into account professional orientation, should be aimed at mastering knowledge of the subject, but also at mastering and activating cognitive activity, developing chemical thinking, and consciously applying the knowledge gained.

Many teachers speak about the need to teach and develop knowledge and skills in chemistry among students in many areas.

Pavlov G.P. described the experience of teaching the discipline "Chemistry" at the Faculty of Chemistry and Pharmacy, describing methods for solving problems related to the specifics of the educational institution (Pavlov, 2015; Shabelskaya, 2010; Lavrova & Mikheeva, 2017, etc.).

But the problem of teaching the discipline "Chemistry" is rather undeveloped, since there are textbooks on this discipline, teaching aids, but there is not enough scientific research on teaching methods, which indicates that this issue is underdeveloped.
Belokhvostov A.A., & Arshansky E. Ya. revealed a whole range of possibilities of using information and communication technologies in teaching chemistry - computer modeling of chemical objects and processes, virtual chemical experiment, etc. The authors paid attention to the methods of computer control of the results of teaching chemistry (Belokhvostov & Arshansky, 2016).

Lyamin A.N. outlined the methodological foundations of the system of integrative learning and theoretical and methodological foundations of integrative studies in chemistry (Lyamin, 2007). Integrative teaching of chemistry in the modern school.

Derkach A.M. used the case method when teaching organic chemistry in college. The author argued that the case method is based on problem learning. The case method allows you to involve the life experience of students and their competencies in the field of organic chemistry in solving problems related to future professional activities.

The teacher gave examples of tasks-situations for work using the case method (Derckach, 2010).

Boschmann E. offered the teaching of chemistry in a television format. The author argues that the remote laboratory component and technology tools should only be used if their use will improve good pedagogy (Boschmann, 2003).

Bopegedera A. M. R. P. believes that teaching chemistry should be first of all practice-oriented (Bopegedera, 2011).

Safina L.G. (2014) offers teaching chemistry using game technologies, which develops thinking, develops analytical and synthetic processes in students, self-determines and forms motivation for learning (Safina, 2014).

M. Yu. Gavryushkina teaches chemistry with the help of instructional materials, which improve the quality of knowledge in teaching chemistry, develop independence (Gavryushkina, 2007).

Based on the analysis of pedagogical literature, we can conclude that the topic of teaching methods of chemistry is relevant today. Therefore, a reduction in the volume of chemistry classes in higher education seems to us unreasonable and unjustified. Moreover, the results of entrance testing show low results, so teachers are forced to start their studies at the university with the basics of chemistry, repetition of the passed material at school, and this is impossible with such a limited number of hours devoted to the discipline "Chemistry" at the TIU branch.

Based on the foregoing, the goal and objectives of our research - based on the analysis of the curricula for the discipline "Chemistry" in the Surgut branch of TIU for 2011 and 2020, the goals formed by the competence, the hours allocated for the study of the discipline to develop optimal methods of teaching the discipline in the new conditions.

**Methodology**

Scientific research methods that we used in the research:

- analysis of curricula for the discipline "Chemistry" approved on September 22, 2011, the direction of training 131000.62 Oil and gas business, by profile: Drilling oil and gas wells; Operation and maintenance of oil production facilities; Construction and repair of objects of pipeline transport systems; Operation and maintenance of technological objects of oil and gas production and a curriculum developed in accordance with the approved curriculum dated 04.22.2019 and the requirements 21.03.21 Oil and Gas Business to the results of mastering the discipline / module "Chemistry";

- generalization of our pedagogical methodological experience in higher education;

- development and testing of teaching materials.

The practical significance of the article lies in the development and application in the pedagogical process of such a methodological technique as the structuring of theoretical material was in the system of structural-Hogical schemes with the possibility of performing independent work on them using a computer and computer programs.

**RESULTS**

Analyzing the curriculum for the discipline for 2019, we note the contradiction between the high real requirements for the results of teaching the chemistry of oil and gas, knowledge of substances and chemical reactions, etc. and the time allotted for mastering this educational material at the university, which does not fully correspond to the tasks of chemical education in higher education.


In a comparative analysis of the requirements for learning outcomes in the discipline "Chemistry" (structure of requirements, content) as a whole, we did not find a clear difference in learning outcomes, namely in competencies.

The 2012 curriculum for chemistry also presupposes the formation of general cultural, general professional, production and technological, and abilities for experimental and research activities.

In the 2019 curriculum, the requirements structure includes a wider range of competencies such as: the ability to search, critical analysis and synthesis of information, apply a systematic approach to solving the assigned tasks; identification of systemic connections and relationships between the studied phenomena, processes and / or objects on the basis of the accepted paradigm. Thus, the main educational competence is to develop the skills of analyzing the problem, highlighting its basic components, searching for information to solve the problem for various types of
requests, distinguishing facts from opinions and assessments; the ability to apply methods of searching, collecting, processing information, using a systematic approach to solving the assigned tasks and carrying out a critical analysis and synthesis of information obtained from current Russian and foreign sources; possession of methods of search, collection and processing, critical analysis and synthesis of information, methods of a systematic approach to solving the tasks.

In addition, students need to master professional competence, namely the ability to solve problems related to professional activity, using methods of modeling, mathematical analysis, natural science and general engineering knowledge; identify and classify physical and chemical processes occurring at the object of professional activity; to determine the characteristics of the chemical process (phenomenon) characteristic of the objects of professional activity, based on experimental research (Shabelskaya, 2010). For this, it is necessary to know the basic physical and chemical laws for solving problems of professional activity, about the purpose and fields of application of basic chemicals and their compounds, methods of their analysis and identification; be able to identify and classify the physical and chemical processes occurring at the facility, to determine the characteristics of the chemical process characteristic of the facility; possess the skills of working with laboratory equipment, conducting experimental and scientific research, methods of analyzing the data obtained and drawing up a report on the work done; know the characteristics of the chemical process (phenomenon) characteristic of the objects of professional activity, based on experimental research; be able to determine the characteristics of a chemical process (phenomenon) characteristic of objects of professional activity, based on experimental research; possess the skills to determine the characteristics of a chemical process (phenomenon) characteristic of objects of professional activity, based on experimental research.

New requirements and competencies were added to the curriculum: the ability to solve problems in the field of professional activity using modern information technologies and applied hardware and software; apply application software for the development and execution of technical documentation. To implement these competencies, students need to know the sources of obtaining information on chemistry, databases, mass media resources, software resources for the analysis and interpretation of available data, information security measures; be able to navigate information flows, select, systematize, analyze information on chemistry, present the results of research in microsoft excel, solve chemical problems using modern information and communication technologies (educon); have the skills to use software to provide a report on the work performed; work with software resources of IUT.

An analysis of the 2019 curriculums for the discipline showed the need to teach a sufficiently voluminous material in comparison with the 2012 curriculum. Lectures were reduced by 4 hours; laboratory work was reduced by 19 hours. At the same time, independent work was reduced by 14 hours.

Therefore, we consider the expediency of optimizing the educational process with the help of educational technologies and allocating most of the educational material for independent study, since it is not possible to implement these competencies within the proposed educational time (17 lessons - lectures, 17 laboratory works).

For independent study, 57 hours are allocated for full-time education in 2019, 70 hours for part-time education and 90 hours for part-time education. We have developed and tested a methodological technique for organizing students’ independent work, which has proven itself well in the educational process when studying chemistry at a university. We developed a series of tasks that we could implement in the educational process support system of Tyumen Industrial University. All theoretical material was constructed in a system of structural and logical schemes. The use of this technique allows you to establish the study of the subject through a dialogue with a computer and a teacher. It is a collection of thematic sections with assignments and tests on this topic. Topics for independent study: classes of inorganic compounds. Basic laws of chemistry; ways of expressing the concentration of solutions; fundamentals of chemical thermodynamics; atomic structure, periodic table, chemical bond and structure of matter; chemical kinetics and catalysis; equilibrium in electrolyte solutions, properties of solutions; chemical equilibrium; ion exchange reactions. Hydrolysis of salts; redox reactions; electrochemical processes; complex compounds; properties of solutions; theoretical foundations of analytical chemistry. Qualitative chemical analysis, quantitative analysis, physicochemical methods of analysis; surface phenomena and adsorption; basic principles of organic chemistry, types of reactions of organic compounds, organic and inorganic polymers, methods of obtaining polymers, structure and properties of polymers, biopolymers; dispersed systems, colloidal solutions, properties and application of colloidal solutions. In the educational process support system, it is possible to conduct a dialogue with students, the teacher can select individual tasks for a certain number of students, i.e. pick up individual tasks and open access specifically for them.

The correct structuring of the material allows you to highlight the basis of the course - the set of basic concepts and statements that underlie any logically coherent subject. The student's work with schemes helps him not only to better understand the content of the topic, the law, but also to acquire the necessary skills of logically accurate reasoning. Experience shows that as a result of exercises, students are better oriented in chemical processes, patterns, and educational material. These schemes are especially convenient for part-time students who do not have time to attend classes. All theoretical material on the discipline is laid down in the structural and logical schemes, logically
planned and organized. Their use accelerates the mastery of chemical work skills by students, individualizes training and significantly saves the teacher’s time spent on monitoring the student’s work.

It should be noted that such a mutual work of studying a chemistry course is laborious. Independent work with the use of a computer and computer programs assumes that students at a convenient time can independently study with the help of any topic, complete a test, test work, and the teacher, in turn, can control and evaluate the quality of knowledge and skills.

An important link in the proposed admission is the correct and objective control over the student’s independent work. We have divided the study material of the semester into several sections according to the course topics studied in the semester. Each such cycle of classes involves the implementation of an individual task, theoretical independent work and final independent work. We have set the deadlines for the delivery of an individual assignment and control activities. Each control element is evaluated in conditional points. In points, the results of the exam are assessed as a final control event. The results of the student passing all stages of control are summarized. The percentage that the received sum of the maximum number of points is, is the value that characterizes the level of knowledge of the student in this academic discipline “Chemistry” on a hundred-point scale of grades.

**Conclusion**

In conclusion, it must be noted that the work on the implementation of the described methodological technique is very voluminous. It requires a lot of time and intellectual effort (especially when drawing up structural logic diagrams and teaching programs) from the teacher.

In the system of issues related to the problem of improving chemical education, further deep fundamentalization of the educational process, aimed at a specific area of professional activity of graduates, namely, oil and gas specialization. The issues of the significance and peculiarities of the subject, the volume and content of the curriculum, as well as the issues of the relationship between fundamental and professional disciplines in the educational process require further more complete and targeted research, consideration of the hourly grid of study time allocated for the study of the discipline “Chemistry”. Our experience in teaching chemistry at a technical university shows that it is necessary to take into account all possible cases of the relationship between chemistry and subjects of the professional cycle by carefully analyzing curricula and teaching aids in a number of specialized disciplines, and then selecting the most important fundamentally directed intersubject connections.

We offer a solution to the problem of lack of time and the integration of interdisciplinary connections by introducing an elective course, which more and more proves its necessity and a great cognitive role in the training system of petroleum engineers. An elective course in chemistry would provide an opportunity to obtain information and consolidate it in laboratory work on issues not provided for in the program of the course “Chemistry” studied in the first year, but necessary for a petroleum engineer.

**References**


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