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Situational tasks in the study of chemistry by students of non-chemical specialties

Abstract. *The article presents situational tasks in the discipline of higher educational institutions «Chemistry» and substantiates the advantages and importance of using this type of task in practical classes. Thus, a specific example of work to reduce the gap between the knowledge and skills of a university graduate and the needs of the employer is given.*

Situational tasks are presented as learning tools that are important to use, on the one hand, to ensure that the teacher develops students' knowledge, skills and abilities provided for by regulatory documentation and, on the other hand, to make students aware of the purpose of studying a particular topic of the discipline, ways to search and find solutions concerning their professional activities, explanation and competent solution of everyday issues.

For example, tasks and assignments on some topics of the course are presented: the basic concepts and laws of chemistry, the periodic system of elements, the energetics of chemical reactions, solutions and the basics of electrochemistry for students of non-chemical specialties of the university studying chemistry as a general educational discipline, which is a prerequisite for basic and specialized disciplines of the specialty.

Such work in practical classes makes it possible to observe the expansion of knowledge and skills of students, an increase in their interest in the chosen profession and in the discipline «Chemistry», socio-psychological satisfaction from their own ability to apply the acquired knowledge in practice and, as a result, an easier inclusion of a young specialist in professional activity and the team.

Keywords: *chemistry at the university; chemistry for non-chemical specialties; situational tasks; tasks in chemistry.*

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Introduction

In our country, there are more than 623 thousand students of higher education institutions currently studying in 120 higher educational institutions (HEIs) [1], acquiring a profession in more than 2 thousand educational programs.

The problem of the gap between the knowledge and skills of a university graduate and the needs of the employer has been voiced many times in various specialties, universities and enterprises. Dual education works well to reduce this gap, but it does not cover all specialties. At the present stage, the competency-based approach in higher education is seen as a way to achieve the skills and abilities indicated in professional standards, because with this approach, the result of learning is «... a set of acquired knowledge, skills, personal qualities and experience of independent activity ...» [2].

The main content of contextual learning [3] is that, in addition to basic theoretical information, there are tasks and problem situations, they model situations that reflect the main job functions. With such an organization of training, it is possible to “lead” the student in the process of

studying profile disciplines through academic-type activities to professional activities, which often, in addition to getting to know real professional tasks during training, can reduce the adaptation period during the transition to work.

The discipline «Chemistry» for non-chemical specialties belongs to the block of general educational disciplines, but even here it is possible and necessary to work on the development of knowledge, skills, certain skills and personal qualities. At Toraigyrov University (ToU), students of about 25 educational programs study this discipline. It is logical that with a close and often with the same list of topics, the content in the curriculum for different educational programs should be different. This can be achieved by using professional examples in lectures, tasks from practice or close to practice in the study of a particular topic in practical classes. A good way to achieve this goal is a situational task.

Materials and methods

The methodological basis of this study is a systematic approach that allows us to present situational tasks as an organizational form of problem-based learning for university students.

Thus, the theory of contextual learning in the process of obtaining higher and secondary vocational education makes it possible to model future professional activities. The personal approach allows us to see the student as an active and creative person in the process of pedagogical work. The activity approach allows us to consider the results of observations in the context of changes and development.

When choosing the presented educational materials, we were guided by the following: tasks are presented taking into account the specialties of ToU; tasks are additional informative; tasks allow, in addition to the actual solution, to significantly expand the knowledge of students; the tasks present real situations of the future professional activity of students, but at a fairly easy level, intended for students of the first or second courses.

Results and discussion

In the methodological literature, there are quite a lot of definitions of the concept of «a situational task» and the content of this concept varies quite a lot. Thus, the author of [4] defines situational tasks as "...tasks that allow the student to master intellectual operations sequentially in the process of working with information: familiarization – understanding – application – analysis – synthesis – assessment". The authors [3] voice the opinion that this is "...a type of educational task that imitates situations that may arise in reality" and which are aimed at "...not finding the actual solution to the problem, but mastering, at the same time, special knowledge and skills, which in the future can serve as a support for the effective resolution of problem situations in professional activities [5]. Another option is tasks that "are developed to test the knowledge and skills of students to act in practical, extreme and other situations [6]. According to [7] «... this is a learning tool, including a set of conditions aimed at solving a practically significant situation to consciously assimilate the content of the subject by students.» The author [8] designates this type of tasks as «... tasks placed in a life context and containing a personally significant question.» Thus, the representation of this concept is broad and, indeed, depending on the level of education, the type and purpose of the lesson, the discipline, on the situation, each of the presented definitions are right. In general, from the analysis of the definitions, it can be seen that situational tasks are, first of all, teaching tools that are important to use for students to understand the purpose of studying a particular topic of the discipline, ways to search and find solutions with their professional activities.

Words [9] "...for an object to interest us, it must be connected with something that interests us, with something already familiar and at the same time it must always contain some new forms of activity, otherwise, it will remain ineffective ..." are considered especially important when planning practical classes. Thus, when studying the discipline «Chemistry», regardless of the similarity of topics, the material in the practical classes must be practice-oriented. This

discipline belongs to general educational disciplines, but even in it, not to mention basic and profile disciplines, it is possible to prepare a student for his professional activity and, by teaching and developing, to expand and strengthen his interest in the profession.

Indeed, almost any of the topics of the discipline can be applied specifically to the specialty (and even specialization), which allows students to master professional skills in addition to mastering and consolidating new educational material in a practical lesson. The teacher, at the same time, has a logical opportunity to provide interdisciplinary communication, give examples of existing industries, deepen the professional knowledge of students, encourage them to understand chemical processes and apply knowledge and skills in everyday life.

When studying the topic «Basic concepts and Laws of Chemistry» in practical classes with students of undergraduate specialties «Ecology», «Biotechnology», «Biology», «Metallurgy», «Chemical Technology of Inorganic Substances», «Construction», «Production of building materials, products and structures» the following tasks can be proposed, for example.

1) Fish species such as trout and grayling are very sensitive to the purity of the water. If 1 litre of natural water contains only $3 \cdot 10^{-6}$ moles of sulfuric acid, then the fry of these fish dies. Calculate the mass of sulfuric acid in 1 litre of water, which is a lethal dose for trout and grayling fry [10].

2) In a school chemistry lab, a solution of hydrochloric acid (10% concentration) was spilt on the floor and by the end of the lesson, it had completely evaporated. Hydrogen chloride is highly toxic and irritating if inhaled. However, the students did not notice any foreign smell. How many molecules of hydrogen chloride were in the air if the mass of the spilt solution is 1 g? [10].

3) During biochemical wastewater treatment without access to oxygen, a mixture of gases was obtained, consisting of 65% of the mass. methane and 35% wt. carbon monoxide (IV). Determine the volume (n.c.), which is occupied by 100 kg of such a mixture [10].

4) Sphalerite is the main zinc mineral ZnS. Ores containing sphalerite are subjected to oxidative roasting. Calculate the volume of oxygen (l) required to roast 100 kg of ore containing 70 % sphalerite [11].

5) Calcium hydroxide, or slaked lime, has the greatest use of alkalis as a binder in construction. Explain what reaction takes place during the setting process and where carbon dioxide comes from during the hardening of slaked lime. Determine what volume of carbon monoxide (IV) (n.o.) is necessary for the reaction with calcium hydroxide weighing 7.4 g [12].

On the topic «Periodic system of elements», in addition to standard tasks and tasks, more often offered by problem bookers, it is possible to offer tasks that are better perceived by students, affecting life situations and the area of their future professional activity. So, for the specialties «Transport, transport equipment and technologies», «Ecology», «Construction» and «Production of building materials, products and structures» on the specified topic, these can be, for example, tasks.

1) You have a suspicion that the employees of the gas station where you constantly refuel add water to gasoline. You have slaked and quicklime on the farm. Can these substances be used to test your suspicions? Will it require any other drugs? [13].

2) Emissions of sulfur oxide (IV) per person in industrialized countries are about 100 kg per year. In the atmosphere, sulfur oxide gradually oxidizes and the product reacts with water. Write reaction equations. What substance is formed? What is the mass of this substance per person per year? [13].

3) To obtain porous concrete, which has high thermal insulation properties, aluminum powder is added to the mixture for its preparation. What chemical reaction results in the release of gas? [13].

4) As a result of archaeological excavations of the camps of the most ancient settlements, numerous samples of organic materials, charcoal and other carbon-containing substances were found. The method of geochronology was used to determine the «age» of these objects. It was found that the discovered objects give 4.4 decays of carbon-14 atoms per minute per 1 g of carbon. Determine the age of ancient settlements [14].

5) For filling balloons in the field, the interaction of calcium hydride with water is sometimes used. How many kilograms of CaH_2 will have to be spent to fill a balloon with a volume of 500 m^3 (n.c.)? How much zinc and sulfuric acid will be required for this purpose? [15].

The topic «Energy of chemical processes» for different specialties («Construction», «Chemical technology of organic substances», «Biology», «Technology of food products», «Chemical technology of inorganic substances» and «Life safety and environmental protection and others») can be interestingly represented, for example, by the following tasks (the conditions of the tasks are given in abbreviated versions without reference data).

1) For welding and cutting metals, a high-temperature flame of acetylene-oxygen torches is used. Give an answer, is it possible to use the flame of a methane-oxygen burner for this purpose? Calculate in which of the two indicated burners more heat will be released during the combustion of the same volumes of acetylene and methane and how many times [14].

2) We get energy from food and drink. Calculate how much energy we absorb by eating 100 g of bread, provided it contains 50 g of carbohydrates, 8 g of proteins, 2 g of fat and 40 g of water. The calorie content of carbohydrates, proteins and fats, respectively, is 3.8; 4.1 and 9.1 kcal/g [14].

3) Calculate the amount of heat released during the explosion of 7.5 litres of explosive gas (n.c.) [15].

4) Liquefied hydrocarbon gas (liquid propane-butane with a density of 0.584 g/cm^3 at 0°C and a content of 58 wt. % propane, 42 wt. % butane) and gasoline (take it consisting of pure octane). Calculate how much heat will be released during the combustion of these fuels and conclude which type of fuel is beneficial for a car enthusiast (taking into account consumption, amount of heat and, possibly, cost) [16].

5) A fit person ate twice the usual daily allowance of chocolate (9200 kJ). Calculate how long it will take him to compensate for energy excesses if: jogging (energy expenditure of the body - 2100 kJ/h), riding a bicycle (920 kJ/h) or washing clothes by hand (540 kJ/h) [14].

Ways of expressing the content of a dissolved substance in a solution, solubility when studying the topic «Solutions» can be worked out when solving similar practice-oriented problems (for example, the specialties «Ecology», «Biotechnology», «Technology of food products», «Biology», «Applied Biology and modelling in medicine», «Metallurgy»).

1) What mass of milk of lime containing 10 % calcium hydroxide is needed to neutralize 1 ton of wastewater containing 0.1 % hydrogen chloride? [10].

2) Curdled milk, yoghurt and kefir contain from 0.6 to 1 % lactic acid. Calculate the molar concentration of lactic acid in these products (take the density of the solution equal to 0.99 g/ml) [10].

3) Calculate the percentage concentration of an aqueous solution of sugar $\text{C}_{12}\text{H}_{22}\text{O}_{11}$, knowing the crystallization temperature of the solution (-0.93°C). The cryoscopic constant of water is 1.86 deg. [17].

4) How many potassium and calcium ions are contained in the blood of an adult if its average volume is 5 dm^3 ? For calculation, use data from clinical studies: 100 cm^3 of blood contains 180 mg of potassium and 6.5 mg of calcium in the ionic form [18].

5) Patients who have lost a lot of blood get into intensive care. If you were an intensive care nurse, how would you urgently prepare 700 ml of saline? The physiological value of blood pH is 7.36. Determine the concentration of ions $[\text{H}^+]$ and $[\text{OH}^-]$ in the blood [18].

The organization of the educational process in practical classes for students of the specialties «Construction», «Production of building materials, products and structures», «Biology», «Agronomy», «Biology», «Applied Biology and Modeling» will help to form professional skills, teach them to look for rational solutions. in medicine», «Chemical technology of inorganic substances» and «Metallurgy», using the tasks below and similar ones on the topic «Fundamentals of Electrochemistry».

1) You boiled white laundry with washing powder and soda in an old galvanized tin tank and found that yellow spots appeared on the laundry that was at the bottom of the tank and

a white, loose coating appeared on the walls of the tank. Why did this happen? Support your answer with reaction equations. How do remove stains from linen and plaque from the walls of the tank? What should have been done so as not to ruin the linen? [13].

2) You can determine the polarity of the battery and rectifier using an ordinary potato. True, in addition to it, you will need two copper contacts, which must be inserted into a fresh cut of a potato tuber at a distance of 2–3 mm from each other and close the circuit. Then, near the positive wire, the flesh of the tuber will begin to turn blue. Due to what processes does this happen and what is the role of the potato? [13].

3) When planting fruit trees and berry bushes, it is recommended to put in a pit for a seedling, together with fertilizers, put several metal cans flattened and burned at the stake. How do you explain this in terms of chemistry? Why do houseplants planted in metal can often grow better than the same plants in clay pots? [13].

4) The mass fraction of sodium chloride in physiological saline is 0.009 (0.9 %). Determine the masses of substances released on inert electrodes during the electrolysis of 40 ml of this solution (take the density of the solution to be 1 g/ml). What is the mass fraction of sodium hydroxide in the resulting solution? [19].

5) In the production of implants in orthopaedics, 50 g of titanium was required as a biocompatible material. How long should the electrolysis of an aqueous solution of titanium (IV) sulphate be carried out at a current of 200 A to obtain the required mass of pure titanium? [20].

Thus, each of the topics of the discipline can be represented by a certain number of tasks that have a certain practice-oriented specificity, which allows, without losing, but increasing the interest of students, to ensure the formation of knowledge, skills and abilities by students provided for by regulatory documents.

Conclusion

In chemistry lessons, the student, being in an active position, in addition to studying the topics of the discipline, develops his social competencies and provides interdisciplinary communication.

Solving situational problems in a practical lesson, the teacher as a whole has a goal - to ensure the assimilation and consolidation of educational material, but by applying practice-oriented situational problems, students, in addition to finding a solution (which is their goal), learn and consolidate educational material, develop new skills and skills, learn to pose and solve problems, formulate their thoughts and more. other.

Despite the standard list of discipline topics and the content of practical classes, the selection of tasks and assignments for students of different specialities can vary greatly. In our opinion, regardless of the similarity of topics, the material in the practical classes must be practice-oriented and speaking, we mean not only the specified discipline. Chemistry, like some other disciplines for many specialities, belongs to general education disciplines, but even in such disciplines, not to mention basic and specialized ones, it is important to correctly build a lesson and prepare the student for his professional activity from discipline to discipline. In addition, it is known that, in general, the use of contextual learning allows, as a result, a young specialist to be more quickly involved in work activities, in a work team.

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Химиялық емес мамандықтар студенттерінің химияны оқытудағы ситуациялық міндеттері

Аңдатпа. Мақалада жоғары оқу орындарының «Химия» пәні бойынша жағдаяттық тапсырмалар беріліп, тәжірибелік сабақтарда осы типтегі тапсырмаларды қолданудың артықшылықтары мен маңыздылығы негізделеді. Осылайша, ЖОО бітірушінің білімі мен дағдысы мен жұмыс берушінің қажеттіліктері арасындағы алшақтықты азайту бойынша жұмыстың нақты мысалы келтірілген.

Ситуациялық тапсырмалар, бір жағынан, мұғалімнің нормативтік құжаттамада қарастырылған оқушылардың білім, білік және дағдыларын дамытуын және екінші жағынан, оқушылардың мақсатын түсінуін қамтамасыз ету үшін маңызды болып табылатын оқу құралдары ретінде

ұсынылады, пәннің белгілі бір тақырыбын оқып-үйрену, олардың кәсіби іс-әрекетіне байланысты іздеу және шешу жолдарын табу, күнделікті мәселелерді түсіндіру және сауатты шешу.

Курстың кейбір тақырыптары бойынша мысалдар мен тапсырмалар берілген: химияның негізгі ұғымдары мен заңдары, элементтердің периодтық жүйесі, химиялық реакциялардың энергиясы, ерітінділер, электрохимия негіздері, химияны жалпы білім беретін пән ретінде оқитын университеттің химиялық емес мамандықтарының студенттеріне арналған базалық және бейіндік пәндеріне қажетті шарт болып табылады.

Тәжірибелік сабақтардағы мұндай жұмыстар студенттердің білімдері мен дағдыларының кеңеюін, таңдаған мамандығына және «Химия» пәніне деген қызығушылықтарының артқанын, алған білімдерін практикада қолдана білуден әлеуметтік-психологиялық қанағаттануын байқауға, тәжірибеден өту және соның нәтижесінде жас маманның кәсіби қызметке және ұжымға оңай қосылуына мүмкіндік береді.

Түйін сөздер: университеттегі химия, химиялық емес мамандықтарға арналған химия, ситуациялық тапсырмалар, химия бойынша тапсырмалар.

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Ситуационные задачи при изучении химии студентами нехимических специальностей

Аннотация. В статье представлены ситуационные задачи по дисциплине высших учебных заведений «Химия», обоснованы преимущества и важность применения подобного вида заданий на практических занятиях. Таким образом, приведён конкретный пример работы на сокращение разрыва между знаниями и умениями выпускника вуза и потребностями работодателя.

Ситуационные задачи представлены как средства обучения, которые важно использовать, с одной стороны, для обеспечения преподавателем формирования у обучающихся знаний, умений, навыков, предусмотренных нормативной документацией, и, с другой – для осознания обучающимися цели изучения той или иной темы дисциплины, способов поиска и нахождения решения применительно к своей профессиональной деятельности, объяснению и грамотному решению вопросов повседневного характера.

В качестве примеров представлены задачи и задания по некоторым темам курса: основные понятия и законы химии, периодическая система элементов, энергетика химических реакций, растворы, основы электрохимии для студентов нехимических специальностей вуза, изучающих химию как общеобразовательную дисциплину, являющуюся пререквизитом для базовых и профильных дисциплин специальности.

Подобная работа на практических занятиях позволяет наблюдать расширение знаний и умений обучающихся, повышение их интереса к выбранной профессии и к дисциплине «Химия», социально-психологическую удовлетворённость от собственной способности применить полученные знания на практике и, в результате, более лёгкое включение молодого специалиста в профессиональную деятельность и в коллектив.

Ключевые слова: химия в вузе, химия для нехимических специальностей, ситуационные задачи, задачи по химии.

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