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INTEGRATIVE LESSON BY THE METHOD OF PROBLEM-BASED LEARNING: BIOGENIC ELEMENTS.

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ABSTRACT

We have taught the topic of "The prevalence of chemical elements in the living and the non-living world", with a problematic method, at the first year of Yerevan State Medical University. This topic is related to biology and physics, one can conduct an integrated lesson in collaboration with teachers of biology and physics. The proposed method allows students to analyze, combine, compare, look for the links between objects and phenomena in class, to understand that " why " is a philosophy of science.

INTRODUCTION.

The purpose of the research is to identify the factors contributing to the problem-learning theory and practice, and to increase the level of effectiveness of teaching natural sciences through the creation and solving of situational problems based on the example of observation of the "Chemistry of biogenic elements" theme. Teaching has been built so that learners can put on their own problems and achieve serious goals, skillfully respond to different situations in life. It is established that the perception of the material is facilitated when the lesson is integrated. The proposed method allows students during the lesson to analyze, compare, look for a connection between objects and phenomena. Pedagogical experiment confirmed the advantages of the proposed method to traditional learning.

Today there is a trend of decreasing interest in the study of chemistry. In the last decade, the structure of school chemical education has changed: instead of a linear system of teaching the subject introduced a concentric system. In the transition to a concentric system of training there was a significant increase in the amount of educational material to be assimilated. But the number of hours allocated by the school curriculum is reduced. Recognition of the existence of these contradictions makes it urgent to search for new educational technologies that, which, on the one hand, would contribute to the formation of a stable positive motivation, and on the other hand, would ensure the implementation of the state standard of chemical education. The success of achieving the goal in the learning process is ensured by the interaction of the teacher and students.

The main task of the teacher is not only to inform, but also to communicate with students about the objective contradictions of the development of scientific thought and their solution. Cooperating with teachers, students acquire new knowledge, get acquainted with the theoretical features of the topic of interest to them.

In this article we will look at the study of new material by the method of problem-based learning. It forms students ' thinking, causes cognitive activity. New knowledge is perceived not by the authority of a teacher, scientist or textbook, but by the power of proving the authenticity of new knowledge through a discussion system. From the methods of problem learning, we chose the Dialogic method of presentation and the heuristic method. In the dialogical method of presentation instead of questions to which the teacher gives answers, information questions are asked and students are widely involved in the discussion. Students in this method are actively involved in the formulation of the problem, put forward assumptions, trying to prove their hypotheses. This method is characterized by the ability of students to realize their search activity, thereby increasing their motivation, the problem is personalized, and knowledge is absorbed more successfully.

The heuristic method of teaching in the concept of M. I.Makhmutov is that the educational material, having the same sequence as in the dialogical method, is divided into separate elements, in which the teacher additionally sets certain cognitive tasks that are solved directly by students. This achieves an imitation of self-study by students, but within the guidance and assistance of the teacher. The teacher himself formulates a problem and by statement of leading questions involves pupils in discussion. Also the teacher helps to organize searching of the solution of the put problem. The help of the teacher limits independence of pupils therefore they participate only partially, nevertheless, it is the most effective method of the organization of a lesson.

We conducted the teaching of "Biogenic Elements" by problem-based learning method. Synthesis of material is easier, if the lesson is integrated, i.e. it is run by chemistry, physics, and biology teachers at the same time. [1]. The proposed method allows learners to

analyze, combine, compare, look for links between objects and phenomena [2]. It is known that each problem has a solution. The only difficulty is to find it.

When planning the lesson, a question arose, - 'in which case is it appropriate to carry out problematic learning? It was decided to solve the problem through a sociological survey. A

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questionnaire was compiled and distributed to lecturers and teachers of various Armenian universities. The results of the survey are presented in Fig. 1.

Questionnaire

During which lesson does the teacher reveal himself/herself better?

1. new material review,
2. past material generalizations,
3. testing the mastering level,
4. all classes equally.

As can be seen from the graph, more than 70% of the 100 respondents think that the teacher is better exposed to the class while studying new materials. This means that problem-based learning technology is being implemented which is directed towards improving the quality of education and personal development, as the learner itself reveals the new knowledge at that time.

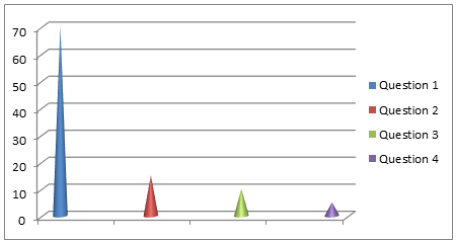

Fig. 1. Survey results

Before the lesson we set ourselves the following issues:

1. each learner has the opportunity to create self-actualization situations,
2. to develop independent working skills through differentiated learning methods,
3. to organize training in such way to develop students' research abilities and intellectual potential,
4. to educate independent decision-makers, inspire confidence, so they feel their value in educational activities.

As a teacher, we relied on the principles of collaborative pedagogy, which exclude ambitious (authoritarian) methods of work of the teacher:

Each student is a personality on their way to success, and the stages of that route may vary. The pedagogue must highlight the personal vision and emotional responses of the student, identify and protect the delicacy of the students' observations, find the "golden beacon" in his answer and defend it [2].

According to the principle of problem-solving, the questions can be informative and problematic. For example, which chemical element lies at the core of earth-bearing minerals? This question is a knowledge containing one and does not have a problematic nature. Such questions do not cause the learner to have active mental activity, so the learner is looking for a ready answer, and the memory provides information without any tension of the brain. This question is also not problematic: from which chemical elements are organic compounds generated? And which question is considered problematic for the learner? Problematic are the questions that cause intellectual difficulties to learners, as there are no responses to the learner's previous knowledge, nor the information given by the teacher.

The problematic question involves an undisclosed problem, an unknown region, a new knowledge that needs intellectual activity, a purposeful mental process [4]. The goal of the pedagogical activity is to develop the student's personality and to discover his creative potential.

A.A. Matyushkin characterized the problematic situation as "a particular type of intellectual interaction between the object and the subject, characterized by the psychological state of a learner that solves the problem, requiring new discovery of unknown knowledge or activity in the subject beforehand" [5]. In other words, in a problematic mentality, the subject wants to solve difficult issues, but he is not satisfied with the data and he needs to find them. The question must have a logical connection between previously used concepts and those that are still subject to learning in a particular educational situation, including cognitive difficulties, causing a feeling of surprise when comparing the new one with the old. This is the situation. Theknowledge of learners is not enough to answer the question, there is a need for new knowledge.

Participation in the process of evolution of transformation of organic substances from inorganic materials has been done with natural selection when creating a biological system. Studies of the chemical components of earth's crust, soil, sea water, plants, animals and human chemistry have shown that they are all of the same elements [6]. However, that pattern is not always maintained.

For example, Earth crust contains 27.6% silicon, while living organisms contain very small amount. The same applies to aluminum: The Earth's crust contains 7.45%, and the organism contains $1 \cdot 10^{-5}$%.

QUESTION .

What explains the contradictions? Remember that why is the philosophy of science. The question arises in the student's mind and causes confusion, **a problematic situation** is created. We carry out the transition from emotional stage to a perception of the problem through a dialogue. Learners are asked to express their opinions, even if they are absurd. They know that they are not graded, that what they say is heard and discussed and that everyone's participation is mandatory.

One of the students expressed her surprise, asking that for the sixth year they are dealing with chemical elements, why no one thought about discussing this issue? This could be done at the lessons of "Chemistry", "Physics", "Biology" and "Natural science".

During the discussion, one of the students suggested that, perhaps, the reason is the practical insolubility of aluminum and silicon oxides in water. And it was the right answer - the "Golden grain" that had to be laid in the basis of the correct answer.

The discussion of the topic continues. As a result of natural selection, living organisms are based on only six elements: carbon, hydrogen, oxygen, nitrogen, phosphorus, sulfur, which are organogenic and compose the 97.4% of the organism. These elements are placed in the first (H), second (C,O,N) and third (P,S) periods of the periodic table D.N.Mendeleyv's.

Why? Creating the **second problematic situation**. Discussions are starting. After discussing many options one of the students, having no other answer, said, "they won't be

composed of radioactive elements? In his answer, it was the "golden grain" from which the right answer was formed. The physics teacher began to discuss the problem of the stability of the nucleus structure. Clearly, those nuclei are stable, which have equal number of protons and neutrons in their nuclei. The number of neutrons and protons atoms in small particles is basically equal, their nuclei are stable, which is the correct answer to the problem. Heavy metal nuclei are unstable because the number of neutrons exceeds the protons, and such nuclei are automatically degraded.

We continue to discuss the new topic of prevalence of chemical

elements in the biosphere. Carbon is in small quantities in the earth's crust - 0.35%, and is in the second place in the living organism - 21%. Organic chemistry examines carbon compounds. About 95% of the known chemical compounds are carbon compounds, and only 5% are the compounds that are generated by the remaining 117 chemical elements (as of April 8, 2018, 141 million chemicals were registered in the US Chemical Registry Service (CAS) [7].

Why does the carbon element generate so many compounds? The third problem situation is created during the same class. What are the reasons for causing a large number of carbon compounds? To solve this problem, there was a need for new, additional knowledge and large-scale work. It was decided to apply the design method of teaching. A volunteer group was formed, which consisted of five learner groups, the group's senior was elected and the chemistry teacher was assigned to follow the group's work.

The discussion of the topic is going on. The next issue concerns the biogenic elements: chemical elements that are essential for the construction and functioning of different cells and organs are called biogenic elements.

To build a problem-learning process, you need to create respective problematic situations. Creating a problematic situation is the most responsible and difficult phase of problem learning. At this stage, learners realize that they cannot solve the problem with their knowledge and they must fill it with a new one. This problem is based on the disagreement between the theoretical knowledge of learners and the knowledge teacher gives during the lesson.

It is known that iron is found in nature in the form of Fe^{3+} compounds. Fe^{2+} ions are easily oxidized into the more stable Fe^{3+} form. Why?

The teacher clearly forms the question. Why is Fe^{3+} ion thermodynamically more stable? Learners propose different versions. These hypotheses are discussed, denied, or accepted if they contain right ideas. During the discussion, one learner offers to consider the electronic structures of these ions. This hypothesis is the expected "golden grain".

Iron is classified as d-elements. 3d sublevels of Fe^{3+} and Fe^{2+} ions unfinished, not completely filled with electrons.

The particle is thermodynamically stable, when its unfinished sublevel is filled with electrons by 50 or 100%. Fe^{3+} ($3d^5$-50%); Fe^{2+} ($3d^6$). This principle also explains the phenomenon of electron failure in some atoms (Cr, Pd, Cu, etc.). The problem is solved, which can be seen in the satisfied expression of the students ' eyes.

The discussion is ongoing. The problem is raised by students. They are enthusiastically asking if the hypothesis we find is right, why is it that in living organisms, in hemoglobin, the central atom of the complex compound Fe^{2+} ?
The problem is initiated. Iron does not alter its oxidation level even in oxyhemoglobin when oxygen joins iron as sixth ligand. The biology teacher and learners are starting to work together to tackle the problem. Various hypotheses are proposed, the rising oxidative reducing (redox) systems in living organisms and their functions are considered. There is no information in the textbooks about this. Moreover, the biochemistry textbooks clearly state that the organism forms an iron storage system where the iron is at +3 oxidation level. The question becomes more complicated, there is confusion, some learners refuse to participate in the discussion, asking for time to think. The issue is given as a home assignment. Everyone is instructed to propose a hypothesis, not to be afraid of making a mistake. The problem is a complicated issue that requires a solution. The problem can be scientific and educational. An educational problem is the question or problem, the method or the solution to which the learner does not know beforehand, but the student has some knowledge and skills to look for the result or task execution method. The problem situation is defined by the psychologists as a person's mental state, which emerges as a result of contradictions. The lecturer's task is to create a problematic situation and inspire students to find a solution to the problem by moving them closer to the goal they seek step by step. In the process of solving the problem, students acquire new knowledge in collaboration with the lecturer. Thus, this form of information ransmission is becoming similar to research activities. The main condition is to maintain the principle of problem-solving when selecting and developing the material in the classroom, directly adapting the content to a dialogue, during the lesson, the teacher should convey his excitement to the learner.

The problematic lesson "The prevalence of chemical elements in the biosphere" was passed with the first-year students of Yerevan State Medical University after Heratsi (EGSU) Faculty of Pharmacy. Educational technology requires a verification of reaching the end result. The effectiveness of the problematic method of learning was studied and concluded by pedagogical experiment. Modern pedagogy with pedagogical experiments is widely used in the method of research, which is used in the testing of the effectiveness of the use of individual methods, curriculum and teaching. The model of a typical pedagogical experiment is constructed on the comparison of experimental and control group [4]. Since it is about testing methodical

learning of one subject of chemistry course, it can be limited to one experimental and one control class. The experiment was conducted by the students of 175 and 179 groups, the pharmaceutical faculty of the EGSU. For all experiments, all group members have been chosen to have similar basic knowledge and skills. In group 179, traditional methods were taught, and in group 175 were organized into a problematic teaching.

To exclude the subjective matter from the comparative value of the advantages of the applied method, the conclusions of the test result are presented in the form of a paper, one by one, and a criterion of grading. The results are summarized in Table 1.

Table 1. Summary of teaching depending on the method

Points Groups	9-10(%)	7-8(%)	5-6(%)	< 5 (%)
175	40	45	15	0
179	12	30	38	20

The conclusions of the comparative analysis confirmed that 175 group students were superior to all students of group 179 (Fig. 2).

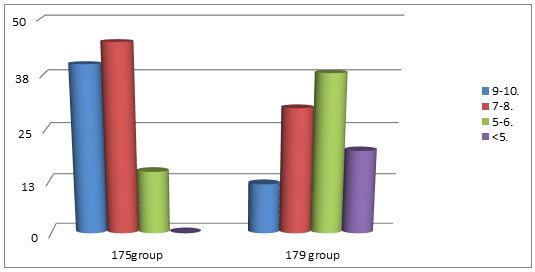

Figure 2. Results of the effectiveness of problematic learning

To consolidate the material we offered to perform exercises on the use of new knowledge. The student is once again convinced that the right decision has been made. Below is a

summery sample survey.

1. When processes occur automatically?
a) $\Delta U < 0$ or $\Delta H < 0$
b) $\Delta U > 0$ or $\Delta H > 0$
c) $\Delta U = 0$ or $\Delta H = 0$
d) $\Delta S < 0$ or $\Delta G > 0$

2. What is the most stable state of a chromium atom?
a) $3d^4 4s^2$
b) $3d^5 4s^1$
c) $3d^6 4s^0$
d) $3d^3 4s^2 4p^1$

3. Which claim is wrong about the iron element in the living organism?
a) the least common heavy metal
b) the most common heavy metal;
c) Participates in the process of oxidation
d) Oxidation rate in hemoglobin +2

4. Which elements are most stable? In which atomic nucleus:
a) the number of protons exceeds the number of neutrons
b) the number of neutrons exceeds the number of protons
c) the number of protons is equal to the number of neutrons
d) number of neutrons >> number of protons

5. Which isotopes are most stable?

1. ${}_{1}^{3}H$ 2. ${}_{4}^{2}He$ 3. ${}_{88}^{228}Ra$ 4. ${}_{6}^{12}C$

a) 1.2
b) 2.3.
c) 3.4.
d) 2.4.

CONCLUSIONS:

The organization of the educational process by the method of problem-based learning is a time-consuming work. But practice proves that such lessons are effective. The student better remember the material, actively involved in the process, increases their motivation to study.

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