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Application of educational games in the teaching of chemistry

The authors of the article consider the possibilities of using the game method of instruction in the study of chemistry. Correctly selected game and tasks allow activating both the learning process itself and creating conditions for the multilateral development of students. The article presents two games «Electronic formula» and «Guess the compound». The main rule of the game «Electronic formula» which guides the players is the strictly consistent construction of electronic formulas of the currently selected elements. As a result, students learn the knowledge of electronic constitution of elements and the ability to build them. The second game «Guess the compound» is based on the question-and-answer principle and ends at the moment when one of the players (or a group of players) with the help of their guiding indirect questions will guess what this substance is. Questions can be asked in different ways, but in general, based only on the chemical and physical properties of the substance being determined. The content and form of the organization of game training contribute to the formation of skills and practical skills, the disclosure of the creative abilities of students. The opportunity is shown to awaken and strengthen interest in chemistry, a sense of collectivism and mutual assistance in solving difficult problems. The possibilities of mutual enrichment with information and skills in the process of the game, the development of the ability to generalize and control the acquired knowledge, confirmed by the long-term use of the game method of learning in the study of chemistry in secondary schools and in higher education institutions are revealed.

Keywords: education, educational chemical games, electronic formula, analysis of substance composition.

The use of new technologies in teaching and upbringing is the most priority in the modern educational process. One of the most effective methods for developing and improving cognitive activity, intellectual and creative abilities of students is the use of gaming technologies. As practice has shown, they contribute to the activation of attention, thinking and quick reaction in solving set tasks. A great contribution to the development of the theory and practice of gaming technologies was made by many foreign and domestic authors, for example [1–7].

As a result of the use of game training methods: 1) cognitive activity is stimulated; 2) mental activity is activated; 3) associative thinking and memorization is formed; 4) develops the ability to solve problematic issues; 5) personality traits are manifested; 6) the motivation to study the subject increases. Game technologies in the chemistry lesson contribute to the acquisition of specific practical skills, consolidating them, turning knowledge into experience. Of course, any learning games should have a great content and cognitive saturation, a scientific content that generates interest in cognition. This strategy can be used to arouse and strengthen interest in the study of the fundamentals of natural sciences, and in particular the subject of chemistry [8]. When using gaming technologies in training, it is necessary to use such methodical procedures that would activate the thought of students, stimulate them to independently acquire knowledge.

It is necessary for the pupil to work actively and enthusiastically in the lessons, to use this as a starting point for the emergence and development of curiosity, deep. The process of the game allows to form the qualities of an active participant in the game process, learns to find and make decisions, develop abilities that can be found in other conditions and situations, to learn consciousness, non-ordinary behavior, the ability to

adapt in the existing conditions set by the game. To learn the ability to communicate, establish contacts, get pleasure from communicating with partners, learn to create a special emotional environment, attractive for students. Game forms can be used both in school and in higher educational institutions, as well as used in conducting non-traditional lessons.

A feature of educational games in the natural sciences is the need for a game form to teach students the laws of a particular science. At the same time, it is necessary to link the educational material with the corresponding teaching game, which is quite a difficult task, since the creation and use of such games require the consideration of a large number of conditions. For training in higher education, there are few such educational games. Therefore, the creation of such games for the natural sciences, in particular for chemistry, is an independent scientific, pedagogical and methodical interest.

One of the first examples of such games in chemistry was presented in [9]. Almost at the same time in [10; 12–65], similar games were shown for use in chemistry classes at higher educational institutions.

It should be noted that the use of educational games in chemistry classes has made it possible to intensify the process of chemistry teaching itself, and therefore, as a first example consider the game called «Electronic formula» which is based on the building of electronic formulas of different chemical elements. The game offered for learning makes it easier by the students to obtain the knowledge they need for understanding the principles of formation of the electron configuration of the chemical elements. The second game given as an example is called «Guess the compound», which allows the determination of the substance, asking the least number of questions about the properties of the ions which compose this compound.

Educational game «Electronic formula»

As is known from the textbooks, the distribution of electrons in the atom by levels and sublevels is represented by the electronic formulas of the elements. For example, the electronic formula of zinc will look like this: Zn — $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2$.

In the learning process, students need knowledge of the electronic structures of elements and the ability to build them. In the educational game «Electronic formula» use the cards, which show the individual components of the electronic formula of the element (see Fig. 1):

Figure 1. Card of the educational game «Electronic formula»

All cards have the same size, for example, with cards that are widely known to us for the card game. The game continues until one of the students-player gets rid of their cards. The main rule that guides players is the rule of strictly sequential construction of electronic formulas of the currently selected elements (naturally, in the order of the sequence of student moves). For example, the teacher decides to check the students' knowledge of electronic carbon, chlorine and scandium formulas. To do this, they prepare cards for the components of the electronic structures of these elements. In the case of carbon having the electronic formula $1s^2\,2s^2\,2p^2$, make 4 cards (see Fig. 2).

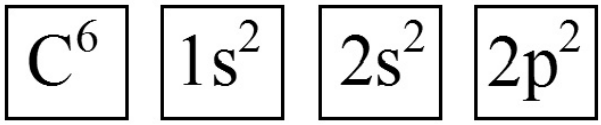
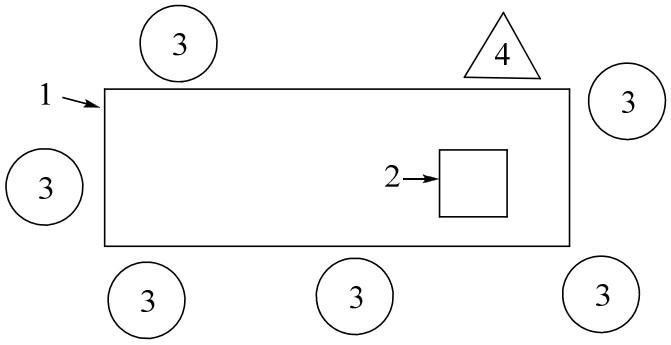


Figure 2. A set of cards for the carbon atom in the game «Electronic formula»

Correspondingly, 6 and 8 cards are prepared for chlorine and scandium having electronic structures: $1s^2\,2s^2\,2p^6\,3s^2\,3p^5$ and $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^1\,4s^2$. Then the cards are mixed and distributed to the playing students. Since the number of cards in this example will be equal to 18 and each player is given at least 4–5 cards, the optimal number of players will be 3–4 players. The sequence and direction of the moves of the participants in the game are agreed in advance. As a rule, the game goes along the clock hand and the first student begins it, sitting in this direction immediately after the person who distributes cards. The distribution

of cards to students performs in turn. The scheme for students' location and the course of the game «Electronic formula» is presented in Figure 3.



1 — table; *2* — frame of the periodic table; *3* — students; *4* — teacher

Figure 3. Location of the game participants

You must strictly follow the rule of compulsory course for each student. In one move, only one card is laid out from the number of cards of chemical elements or the electronic formulas that make up them. The game «Electronic formula» is carried out using the Table shown in Figure 4.

Figure 4. Table of the educational game «Electronic formula»

Cards with components of electronic structures can be laid out only after the card with the chemical symbol of the corresponding element is put. For example, proceeding analysis of the task described above, let's say that when distributing cards our student got the following ones (see Fig. 5).

Cl^{17}	$2\ s^2$	$2\ p^6$	$3\ s^2$	$3d^{10}$

Figure 5. Cards received for the game by the student-player

To his first move, we can assume that the following game situation will appear on Table, shown in Figure 6.

C^6	$1\ s^2$	$2\ s^2$				
Sc^{21}	$1\ s^2$					

Figure 6. The situation of the educational game «Electronic formula» at the moment of the student's possible move

Our player can make, according to the rules of the game, two possible moves. The first is to go with a card of chlorine, while opening up opportunities for other players, allowing them to get rid of other cards, the second — with a $2s^2$ or $3s^2$ card, continuing the already begun series of respectively carbon or scandium. The

second move seems naturally more profitable for the player because he has a card $3d^1$, which he can lay out, sending the game in the direction of building the corresponding for the scandium series. This is also correct in that he can use the $2p^6$ card in this row. And chlorine cards also allow other players to orientate the game in a direction more advantageous for them.

Thus, the educational game «Electronic formula» gives students the specific subject knowledge and has a direct impact on the formation of such qualities of students as the system approach, flexibility, and understanding of the basic law of chemistry.

Educational game «Guess the compound»

The «Guess the compound» educational game is simple both in design and by the rules. Any number of students can take part in it in any quantitative ratio. The basic principle of the game is the question-and-answer, and it ends at the moment when one of the players (or a group of players) using his leading questions will guess the substance hidden from him (her). The opposite side, respectively, selects the substance, in the literal sense of the word or theoretically, and answers the questions of the requesting side. The answers can only be unambiguous «yes» or «no». Questions should be as clear and simple as possible. That player (or team) wins, who will determine the substance, asking the least number of questions. The game is more convenient to carry out, thus, when one student stands on the board, and the rest, having chosen up the substance, answer the questions. Then there is a change of players in order of priority. The game ends when all students already had have been in the role of guessing player. If the number of players in the group is large, then it is recommended to play with teams. For a more complete understanding of the game, let's analyze the corresponding example. It deals with the chemical properties of selected compounds from the cations and anions. Suppose that for the game the group has offered a solution of the silver nitrate salt. How can the student guess this problem? For this, one of the possible variants of questions and answers with comments to them is supplemented then.

Question: Is it a solution?

Answer: Yes.

Question: Is it colored?

Answer: No.

Two of these questions make it possible to determine whether a solubilized unknown substance is well dissolved in water (or some other solvent, which it is desirable to specify by asking an additional question: is the solvent the water?). And whether there are colored anions or cations in solution. If they are available, it is recommended to find out their color, giving additional information. In our case, this is not the case, and further questions can be asked in different ways, but in general, based only on the chemical and physical properties of the substance being determined. Asking questions like this: the substance cation is in the first group of the periodic table? — is not allowed, because such generalizations do not give a more complete picture of the game, so further questions can continue in the following order:

Question: Is the cation of substance monovalent?

Answer: Yes.

Knowledge of the valence of the cation sharply narrows the circle of cation search. Anion ions reacting with the cation can also act. In our case, the cation circle is limited, and therefore the greatest effect can be given by the question concerning anions that can precipitate a number of related cations.

Question: Does the substance cation form a precipitate in an ammonia solution with a carbonate ion?

Answer: No.

Question: Does the substance cation form a precipitate with the chlorine anion?

Answer: Yes.

Thus, using the leading questions given above, it was possible to find out that the required cation is precipitated with hydrochloric acid. Further determination of the cation does not cause difficulties. The cation is monovalent, so, it can be Hg^{2+} or Ag^{+}. We will know the cation by asking the question: «Does the molecule of the chloride precipitate contain two anion atoms?» Having determined the silver ion, we proceed to find the nature of the anion. This process is simplified since we know that not all anions give a colorless solution with Ag^{+}. The determination of the anion is carried out, in the main, already disassembled above. So, one of the recommended questions can be:

Question: Is the anion of substance monovalent?

Answer: Yes.

Question: Does the combination of this anion with the hydrogen ion form a very common acid?

Answer: Yes.

Question: Is it a complex anion consisting of several atoms of two elements?

Answer: Yes.

After these questions and answers, students almost always become clear that the anion which needed to guess is silver nitrate.

In future, the order of the game does not change much. After determining the substance, the total number of questions is recorded for the following comparison with the results of other students. The teacher during the training game «Guess the compound» serves as a referee and consultant.

Thus, from the material discussed above, it is clear that the game «Guess the compound» forces students to use not only all their knowledge but also develops such valuable qualities for specialists as logic, initiative, ingenuity, non-standard thinking and much more. It is also important that the game can be used from the very first steps and until the end of training course, up to the exam. Recommend only to take into account the preparedness of students for the subject in the compilation and selection of tasks for the game. It is usually better to give for guessing the problem, consisting only of one substance, element, which is especially valuable for the first periods of training of students in chemistry.

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Химиядан білім беру барысында ойын арқылы оқыту әдісін қолдану

Мақала авторлары химиядан білім беру барысында ойын арқылы оқыту әдісін пайдалану мүмкіндіктерін қарастырды. Дұрыс таңдалып алынған ойындар мен тапсырмалар оқу процесі барысындағы білім алушылардың белсенділігін арттыруға және олардың жан-жақты дамуына мүмкіндік берді. Мақалада «Электрондық формула» және «Қосылысты тап» ойындарын қарастыру

ұсынылған. Ойыншылардың «Электрондық формула» ойыны бойынша ұстанатын басты ережесі таңдап алған элементтің электронды формуласын қатаң түрде біртіндеп құрастыру болып табылады. Нәтижесінде оқушы элементтің электронды құрылымын біліп, оны құрастыруды үйренеді. Екінші ойын «Қосылысты тап» сұрақ-жауап принципі бойынша жүргізіледі және ойыншылардың бірі (немесе ойыншылар тобы) олардың жанама сұрақтарының көмегімен осы заттың қандай екенін білген сәтте аяқталады. Ойын арқылы оқытуды ұйымдастырудың мазмұны мен формасы білім алушының шығармашылық қабілеттерін ашып, практикалық дағдылары мен біліктілігін қалыптастыруға ықпал етеді. Химияға қызығушылығын оятуға және арттыруға, қиын мәселелерді шешуде ұжымдық және өзара қол ұшын беруге деген мүмкіндіктерін қалыптастыру көрсетілген. Ойын процесі барысында білім алушының ақпарат пен дағдыларының қалыптасуы, алған білімдерін жалпылау және бақылау мүмкіндіктерінің жетілуі жалпы білім беретін мектептерде және жоғары оқу орындарында ойын әдісін ұзақ уақыт бойы қолдану дәлелдеп отыр.

Кілт сөздер: білім беру, оқу-химиялық ойындар, электрондық формула, заттардың құрамын талдау.

Н.К. Ахметов, Г.Т. Азимбаева

Применение учебных игр в преподавании химии

В статье рассмотрены возможности применения игрового метода обучения при изучении химии. Правильно подобранная игра и задания позволяют активизировать как сам процесс обучения, так и создать условия для многостороннего развития учащихся. Авторами представлены на рассмотрение две игры «Электронная формула» и «Угадай соединение». Главным правилом игры «Электронная формула», которым руководствуются игроки, является строго последовательное построение электронных формул выбранных в данный момент элементов. В результате у обучающихся формируется знание электронных структур элементов и умение их построить. Вторая игра «Угадай соединение» ведется по принципу вопрос – ответ и заканчивается в тот момент, когда один из играющих (или группа играющих) с помощью своих наводящих косвенных вопросов догадается, что это за вещество. Вопросы могут задаваться по-разному, но в целом основываясь только на химических и физических свойствах определяемого вещества. Содержание и форма организации игрового обучения способствуют формированию умений и практических навыков, раскрытию творческих способностей учащихся. Показана возможность пробудить и укрепить интерес к химии, чувство коллективизма и взаимовыручки в решении трудных проблем. Раскрыты возможности взаимообогащения информацией и умениями в процессе игры, развития способности к обобщению и контролю полученных знаний, подтвержденные многолетним применением игрового метода обучения при изучении химии в средней школе и в высших учебных заведениях.

Ключевые слова: образование, обучающие химические игры, электронная формула, анализ состава вещества.

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