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### **The game as an interactive method in teaching chemistry and environmental education in grade 7**

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**Abstract:** *Creating a lasting interest in learning and overcoming the negative attitude towards the subjects of the natural cycle, is an important task for the modern teacher. A very good opportunity to solve it is provided by the gaming training methods. Involving students in the learning process stimulates self-reflection, creative imagination, decision-making skills, and communication tolerance. The use of gaming methods increases the cognitive interest of the students.*

*The goal of this paper is to present the results of a research related to development and application of didactic games system in the process of chemistry and environmental education in the 7th grade classroom. These games allow effective and enterprising absorption of chemical knowledge and contribute to maintaining students' interest in chemistry.*

**Keywords:** *game methods, cognitive interest, motivation*

#### **Introduction**

The problem of the effectiveness of the training is closely related to the interest of the students in the relevant science and the subject matter, with their willingness to actively participate in the process of acquiring new knowledge and skills. In recent years there has been an alarming decrease in the interest in chemistry and the motivation for its study. This is due to both the increasing amount of information in school textbooks and the decreasing number of hours spent studying it, as well as the negative attitude towards chemical industries considered as major environmental pollutants. In order for students to become active participants in the learning process, they should be organized to stimulate their cognitive interest.

Cognitive interest is created when the lesson demonstrates not only the content of the subject matter but also provides the conditions for independent creative work – an opportunity that is provided by the interactive learning methods. They take into account the modern needs, the shift of priorities – from the acquisition of ready-made knowledge in the course of the lesson, to the independent, active cognitive

activity of each student, taking higher abilities into account. Most often, these methods take the form of group work, and through the interaction between the participants in the group, a favorable environment is created that helps learners socialize, tolerate communication, which stimulates their creative thinking and new ideas.

Gaming methods, as part of the interactive method, provide very good opportunities for creating and developing cognitive interest. The use of games in the learning process helps to stimulate student activity, develops initiative, observation, attention, creative imagination. The game reduces fatigue because it makes the learning process entertaining and exciting. In the course of the game, learners acquire new knowledge, skills and competences, and expand their worldview.

The need to create a lasting interest in learning and to overcome the negative attitude towards the subject of chemistry and environmental protection determined the aim of this study: development and implementation of a didactic game system in the process of chemistry and environmental education in the 7th grade, in order to enable effective and fun learning of chemical knowledge and to keep students' interest in chemistry. This paper presents the results of the research.

### **A theoretical statement**

The idea of fun learning that provokes the interest of students and stimulates their cognitive activity dates back to centuries ago. Even the ancient Greek philosopher Plato in the 4th century BC makes the following recommendation in his *State of the State*: „Train the boys of science not violently, but as if they play ...“ [7, p. 354]. The Roman rhetorical teacher Quintilian us advises: „Let the learning be a game ...“. The game, he says, can be not only a means of relaxation between serious classes but also a method of learning. It proposes the inclusion of a competition among pupils as a game task that stimulates their cognitive activity [2, p. 47].

The term „game“ in the Bulgarian vocabulary also means „entertainment“; a set of entertainment activities subject to certain rules [1].

DM Elconin defines game as „... such an activity in which social relationships between people are recreated as unconditional, immediate secondary activity“ [4].

In the learning process the game gains a wider sense. In scientific-methodological literature, it is associated with activity as a „joint expression of the subjective experience of the teacher and the learner, self-defining themselves as participants in various models of the game space“ [5].

According to I. Ivanov, „the game is a type of simulation requiring active participation with application of the acquired knowledge. As a learning method, it is an imitation of reality in one or another artificially created situation. It diversifies frequently asked exercises, does not bother the participants and is fun and attractive“ [6].

The question of activating the students' cognitive skills is one of the most significant and up-to-date in the theory and practice of modern training. An important prerequisite for keeping the learners' attention and the main motivation for learning is students' interest. In pedagogical-psychological literature, it is considered „... as a complex attitude of the pupil towards the objects and phenomena, in which he/she expresses his/her desire for serious and in-depth study and acquaintance with their essential properties“ [3].

Cognitive interest occurs only after the environment is organized to meet the need, that is, it is diverse, new, interesting, emotional, etc.

The didactic game activates psychic processes, makes the learning content attractive, produces positive emotions in the play, facilitates the process of learning, and thus stimulates the cognitive interest.

### **Results and discussion**

The content of the 7th grade HEI is grouped into several global themes: Substances and processes, Chemical symbolism and valence, Metals - sodium and its compounds, Non-metals – Chlorine and its compounds, Periodic law and periodic system, Chemical processes in nature, everyday life and production.

In order to raise interest and support learning during the research, we used a system of didactic games. Their application is appropriate in every stage of the macrostructure of the lesson in accordance with the goals the teacher has set.

The study was conducted with the students of the 7th grade of the Sofia University „John Bulgarian Exarch“, who learn the subject with the help of the book of Prosveta publishing house, 2009. Part of the games were included in the training process during the pre-graduate practice. The experiment continues this year and will be held with students from the 7th class of MG "Dr. P. Beron" Varna.

Our observations and past research have shown that one of the most difficult topics to learn is the topic of Chemical Symbolism and Valency. In this topic, students learn about the most abstract and difficult to learn component of the chemical language - chemical symbolism, which includes chemical symbols, chemical formulas and chemical equations. Parallel to the introduction of the chemical symbols in the subject is the knowledge of chemical element names and rules for compiling the names of binary compounds and chemical formulas by a given valence. The introduced character system is further enriched with the algorithm for writing and equalizing chemical equations, and is transformed into the more complex symbolism of the following theoretical levels. By studying the Alkaline and Halogen groups and the Periodic System knowledge is specified, supplemented and enriched with new chemical symbols and the corresponding names of the elements and substances. The use of this specific information makes it difficult for students to learn, and many of them lose confidence and interest in learning.

The lessons learned have led us to develop didactic games to diversify the learning content, support learning and stimulate students to participate actively in chemistry and environmental education.

In the lesson „**Chemical Signs**“, we've featured the „**Find Chemical Mark**“ and „**What We Know About Chemical Signs**“ games.

The didactic goals of the games are focused at acquiring knowledge about identifying the chemical signs of the chemical elements and the skills to associate them with the corresponding names; for information that carries the signs of chemical elements; for the meaning of coefficients against chemical signs and indices in the signs of the ions. At the same time, attention is intensified, imagination, intuition, and pupils' observation is developed.

Games can be used to reinforce new knowledge as well as by the update in the next classes or in lesson exercises.

We present the content of the games.

#### „**Find the Chemical Mark**“

The class is divided into two teams. Maps with names of chemical elements have been prepared. Participants from both teams download one card. There are maps with the chemical signs of the elements in the container. Each participant must find the sign of his chemical element in the court. The winner is the team which gathers the most correct answers (chemical signs).

#### „**What do we know about chemical signs**“

On the cards, the chemical sign of the element on one side and its name on the other side are recorded. Students ask questions in pairs. A winner is chosen from each pair. The winners ask each other questions in pairs, but the cards already have signs of ions of chemical elements and characters that have been recorded coefficients. Winners draw cards with questions related to the detection of chemical signs and the names of chemical elements, the information that chemical symbols carry, the location and role of the coefficients. The winner is the pupil who answered the most questions, in a full and comprehensive way.

<b>H</b>	<b>O</b>
hydrogen	oxygen

In the units of study related to the study of chemical formulas and the names of the substances, a qualitative and quantitative analysis of the chemical formulas is made, their first classification is proposed, the rules for the formation of formulas by given valence are introduced. The teaching in each lesson indicates the substances that are labeled with them. Although hours of exercises and acquirement of new knowledge is provided, students have difficulty in understanding the content of chemical formulas, not

establishing exactly how they relate to the specific substances they designate because the substances themselves are not studied. To make it easier to understand and make sense of the ways in which chemical formulas are formulated and how they relate to substance names, we have developed the „**What's the Matter**“ and the „**Berzelius Labyrinth**“ games.

The game „**What is the substance**“ is conducted according to the rules of the game „**Find the chemical sign**“. It is applicable at the stage of consolidation of new knowledge in the subject Substance names.

The Berzelius Maze game was created in the exercise Formulating chemical formulas. We offer two versions of the game.

#### Version 1

Students once again are divided into teams. Each team receives a card from the teacher with different chemical symbols. Students are expected to compile and record all possible chemical formulas that are obtained in the right combination of these and name the corresponding chemical compounds. The winner is the team that has properly formulated the chemical formulas and named a large number of chemical compounds for a set time.

For example: for a team - P, Cl, O, S, Na, Fe, H

#### Option 2

On an interactive board, a multimedia projector or cards, parts of chemical formulas are recorded (fig.1). Students should find the missing part and compose the possible chemical formulas.

For example: Na<sub>2</sub>, Cl, H, O<sub>5</sub>, H<sub>2</sub>, S, P<sub>2</sub>, O, Br, Ca, Cl<sub>2</sub>

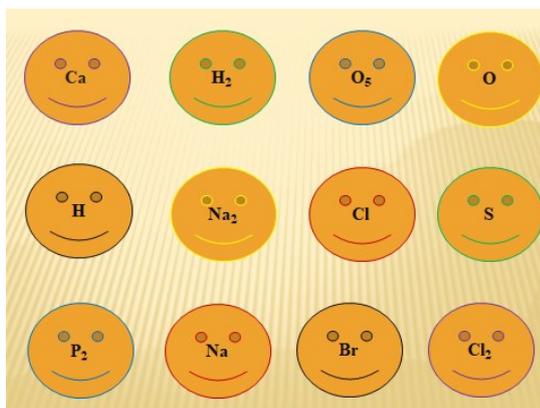


Figure 1. Elements of the didactic game „Berzelius's Maze”

The compilation and equalization of chemical equations also hinders students. To consolidate the algorithm of writing a chemical equation and forming equations to equalize chemical equations in the exercise lesson, we used both versions of the game „**Ignore the Chemical Element**“.

Students are divided into groups again.

#### Version 1

Each student in the group receives one chemical equation in a mixed form in the form of cards. The goal of the game is to make sure that each group correctly aligns their chemical equations. The winner is this group that first tackled the task and correctly formulated and equalized the chemical equations.

#### Option 2

Each group receives an envelope with cartons, in which components of 10 chemical equations are written (chemical symbols, chemical formulas, coefficients and binding characters) which must be arranged for a certain time. The group that has correctly sorted the largest number of chemical equations is the winner.

During the general lessons where the learning content is already solidified and summarized, students usually lose interest. To diversify the work in these lessons, gaming competitions are particularly suitable. They awaken the participants' activity and competing spirit, they are emotional, and there is long term memory.

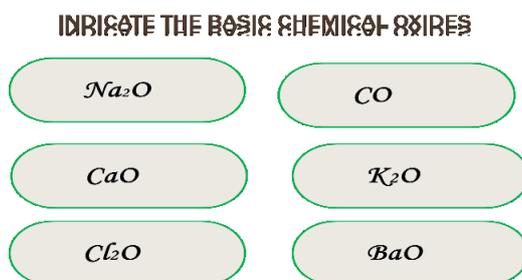
The Alkaline group compounds of the alkali and halogen group. We played a didactic game to consolidate and summarize the knowledge of the basic terms and concepts related to the diffusion of the elements, their physical and chemical properties; building skills to express chemical properties with chemical equations, and stimulating student interest and motivation for learning. We used an interactive board as a didactic tool.

The game prepares 15 questions on an alkaline/halide group that are designed using the interactive board. The class is divided into three groups. Each group has the right to answer 5 questions. When the most correct answers are gathered, the group wins. One student from a group that has been more active goes out in front of the class. The teacher asks three additional questions. The group whose representative answers most of the questions wins.

The game **Simple Substances and Compounds**, conducted within the framework of the relevant lessons, allows the knowledge of the main classes of inorganic substances and of the chemical symbols to be identified. It stimulates the cognitive activity and the interest of the students, and helps in the development of their thinking through the formation of skills for the transfer of acquired knowledge in a new situation. It is appropriate for that activity to take place at the end of the second lesson in order for the students to gain more knowledge or at the beginning of the next lesson when their knowledge is being tested. An interactive board or multimedia is used as a didactic tool (fig.2). It can be held as a group or individual competition.

Tasks are designed on an interactive board or multimedia, and students are pre-handed with lists with question numbers and tables, in which they make a note of the correct answers.

The group or students who has given the most correct answers for the set time wins the competition.



**Figure 2.** Slide from the game „Types of simple substances and chemical compounds”

To strengthen the knowledge on chemical signs and the place of the elements in the Periodic Table in the Lesson Exercise "Significance of Periodic Law and Periodic System" students can be offered game "Supplement Periodic System". The task of the students is to fill the empty spaces in the chemical signs (fig.3).

PERIODICHNA СИСТЕМА НА ХИМИЧНИТЕ ЕЛЕМЕНТИ																		
период	I		II		III		IV		V		VI		VII		VIII		IX	
1	(H)																	He
2	Li	Be	B	C	N	O	F	Ne										
3	Na	Mg	Al	Si	P	S	Cl	Ar										
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni								
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd								
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt								
7	Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

**Figure 3.** Game „Complete the Periodic table”

The class is divided into groups by rows. Each row deals with a single PS in which there are no signs of chemical elements that are known to the students. Each student has the right to record only one chemical sign. The group that quickly completed its PS wins.

For the same unit we developed the didactic game-competition chemical signs and famous scientists. Didactic tool – interactive board or multimedia.

Slogans are recorded with chemical signs of the chemical elements (fig 4). The task of the students is to find the names of the chemical elements in the periodic table. The first letters of the name form the name of a known chemist. The student or group who discovered the name of the scientist first wins. A brief biographical report is designed, then we head to the next slide and then to the end. The student or group who have found the most names of chemists wins.

**Li Ar H Os Al Au Ir Eu**

## ЛАВОАЗИЕ

Антоан Лоран Лавоазие (1743-1794)

Френски химик, член на Парижката академия на науките (1772) и нейн председател (1785), един от създателите на съвременната химия. Той е установил: ролята на кислорода при горенето и дишането (1780), независимо от Джоузеф Пристли и Карл Шееле; Лавоазие е създател на химическата номенклатура (1786 – 1787), чиито основни принципи са запазени и до днес. Доказал е, че т.нар. „земи“ (окисите на калция, бария, магнезия) не са прости вещества, както се е смятало дотогава, а кислородни съединения на съответните елементи. Лавоазие е един от основателите на термохимията; въвел е принципите на физико-химичното изследване и в областта на биологията.



Figure 4. Slide from the game „Chemical elements and famous scientists”

In the topics **Substances and chemical reactions in nature and the practice of man and The role of man in the environmental protection** which will be developed during the entire course of study, namely that the studied substances and processes will be viewed in the light of their importance to man and the environment. In order to draw the students' attention to these issues and make the topic interesting and memorable, we used the game “A minute too late”.

To complete the game, students are divided into teams. Each team receives a puzzle that includes terms from the two lessons associated with the goal we have set. The task of the teams is to find terms in the table related to nature, substances, chemical reactions and environmental problems and to write at least one characteristic for each of them for a certain time.

For example:

1.	Б	А	П	И	Х	И	Д	Н	Е	Ф	Т	Е	Р	А
2.	Р	А	К	И	С	Л	О	Р	О	Д	С	О	К	М
3.	А	П	Е	С	Т	И	Ц	И	Д	И	Ф	С	И	Н
4.	Л	О	Р	С	Е	Ж	И	В	О	Д	О	Р	О	Д
5.	Р	Е	К	О	Л	О	Г	И	Я	Х	Е	А	М	И
6.	Б	А	П	И	Х	И	Д	Р	О	С	Ф	Е	Р	А
7.	Г	П	А	Р	Н	И	К	О	В	Е	Ф	Е	К	Т
8.	И	В	О	Д	П	А	Р	И	Е	Р	А	В	И	К
9.	П	С	Е	Р	Е	Н	Д	И	О	К	С	И	Д	А
10.	Б	И	Р	Т	О	Р	О	В	Е	Ч	В	И	Е	Л

In the course of the experiment, other interactive methods and forms were used along with the didactic games – brainstorming, case studies, debate, method of associations, group work, etc. They were included in separate methodological units or in separate lesson fragments.

Students' attitudes towards the subject and interactive learning were diagnosed using a survey. Given the theme of the development we will only present the results related to the game methods.

To the question: Which learning objects are you studying with desire and interest? Arrange them in the table in the order of your preferences. Against your chosen subject, note the reasons why it is desired and interesting for you, 60% of students put chemistry and environmental protection among the subjects they are interested in and 26% of them put it first. When the reasons why the subject is desired and interesting, 50% of the students indicated that they liked the way they collaborated during the lessons, while 34% said that the teacher taught the lessons in an interesting way. 38% of the respondents answered that they were active during the lesson if the material they studied was interesting and 45% - if the teacher used games, case studies, discussions, etc. during the lesson.

The survey showed that students want to use non-traditional methods and forms in their training because they can express their personal opinion (17%), they can communicate with their friends (26%), they can play (39%) and they can make presentations, drawings, collages, posters (18%).

To the question: „Which of the methods and forms used motivate you to be passionate about the work?“. All the students surveyed indicated more than one answer. Responses are distributed as follows: 91% for gaming and group work; 56% for solving puzzles and crossword puzzles, 50% for solving case studies and computer work.

### **Conclusions**

Students' observation in the game-making process and the conducted survey convincingly confirm the expedience of the study. The results show that the use of games in learning increases the cognitive interest and activity of learners, stimulates the process of searching for new knowledge and provides conditions and opportunities for expression. In addition to interest in the subject, participation in game activities teaches students to overcome difficulties, make quick decisions, develop creative thinking, attention, speech and memory, and it helps them master the chemical language and chemical concepts.

### **Acknowledgment**

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