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METHODOLOGY FOR STUDYING MODERN METHODS OF ORGANIZING INDEPENDENT WORK OF STUDENTS IN INORGANIC CHEMISTRY IN HIGHER EDUCATIONAL INSTITUTIONS

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Abstract
This article discusses the methodology for using interactive methods and graphic organizers in organizing independent work of students in inorganic chemistry in higher pedagogical educational institutions. The impact of such methods as “FSMU”, “Insert”, “Charkhpalak”, “Cluster”, “BBB” on the effectiveness of independent learning is analyzed. The results of the study showed that interactive methods develop students' skills of independent thinking, analysis and deep assimilation of knowledge.

Keywords: Independent learning, inorganic chemistry, interactive methods, graphic organizers, FSMU, cluster, pedagogical technology, credit-module system.

Introduction

After our country gained independence, major practical reforms began to be carried out in the education system , and these reforms are currently being enriched with the best practices of the world education system, the latest achievements of information and communication technologies, and the most innovative and effective teaching methods. The continuous introduction of such innovations in the education system allows students to easily master new knowledge and apply the acquired knowledge in practice. The tasks set out in the Concept for the Development of the Higher Education System in the Republic of Uzbekistan set the priority areas of raising the educational process to international standards, introducing a credit-module system, and developing students' independent work skills. Under the credit-module system, the share of students' independent work (IW) is 40-60 percent of the total workload of the subject. This makes the development of effective and innovative methods of organizing IW an urgent task .

Inorganic chemistry occupies an important place in pedagogical higher educational institutions. This subject is considered the main tool for forming the scientific worldview of future chemistry teachers. At the same time, inorganic chemistry creates serious difficulties for students in mastering it due to the abundance of abstract concepts , the complexity of chemical language, and the specificity of chemical calculations [1].

The concept of "independent education" occupies a central place in the modern higher education system. In the scientific and pedagogical literature, this concept is defined in various ways. In a general sense, independent learning is understood as the process of a student actively, purposefully and systematically acquiring new knowledge, skills and competencies without the direct guidance of a teacher, but with his participation as a consultant .

And graphic organizers in organizing independent work of students in inorganic chemistry in pedagogical higher educational institutions . The study analyzed the impact of such methods as “Carousel”, “Boomerang”, “FSMU”, “Insert”, “Cluster”, “BBB”, “Venn Diagram” on the effectiveness of independent learning on an experimental basis, and their pedagogical effectiveness in increasing students' independent thinking, analytical approach and the level of knowledge acquisition was determined.

Nowadays, the introduction of modern pedagogical technologies, computers and interactive methods into the educational process is one of the important tasks, and teaching methods are a form of interaction between the teacher and the learner. Demonstrative and interactive methods play an important role in education, since a person absorbs information more through seeing and hearing , and active participation enhances the consolidation of knowledge. Teaching methods are divided into passive, active and interactive types, and especially interactive methods (for example, “Brainstorming”, “Case Study”, “Cluster”, “Venn Diagram”, etc.) encourage students to think independently, analyze and take a creative approach. The correct selection and use of interactive methods increases the effectiveness of education, ensures the activity of students and deep assimilation of knowledge.

Interactive methods are methods aimed at increasing student activity in the learning process, developing independent thinking and a creative approach [1]. The word “interactive” means “mutual action”, that is, in these methods there is active communication and cooperation between the teacher and the student, between students [5]. The use of interactive methods helps to organize the educational process in an interesting, effective and learner-centered way.

The importance of interactive methods for independent work is as follows [2, 6]:

- the student's interest and motivation in MI increases;
- the student becomes an active participant, not just a listener;
- it becomes easier to master abstract concepts;
- skills of analysis, comparison, generalization are developed;
- The student acquires a culture of defending his or her own opinion and respecting the opinions of others.

The “Carkhpalak” technology is an interactive method based on students checking and evaluating each other's work [5]. The procedure for using this technology in MI:
are divided into small groups of 4-5 people.

2. Each student completes the MI assignment individually and places a unique symbol (e.g., flower, asterisk) at the end of their work.
3. Work completed is shared among group members.
4. Each student checks their partner's work, corrects mistakes , and adds their own thoughts.
5. The work is then passed on to the next group member. The process continues until the work is returned to its owner.
6. The student analyzes the corrections and additions made to his/her work and evaluates himself/herself.
is effective in inorganic chemistry, especially in investigating the properties of substances and the formulation and calculation of chemical reaction equations [4].

Boomerang technology is an interactive method based on students teaching each other and exchanging ideas [8]. The procedure for using it in MI:
1. The student independently studies an MI assignment (for example, a specific topic).
2. Students form small groups and each group presents the material they have learned to their peers.
3. Group members ask each other questions and clarify areas they don't understand.
4. Peer control is carried out within the group.
5. Students return to their original position and consolidate their knowledge.
The "boomerang" technology is especially effective in independently mastering topics such as atomic structure, types of chemical bonds, and the arrangement of elements in the periodic table [7].
The "FSMU" method is an acronym for Thought, Reason, Example, Generalization [12]. This method teaches the student to express his/her opinion fully and systematically. The "FSMU" method is an interactive teaching method consisting of the initials of the words Idea, Reason, Example and Generalization, and serves to develop students' independent, logical and critical thinking skills. This method teaches students to express their opinion in an orderly, well-founded and consistent manner and is an effective tool for analyzing problem situations. In the first stage of the method, in the "Opinion" section, the student expresses his/her personal opinion on a given topic or problem. In the second stage, in the "Reason", he/she explains exactly why he/she came to such an opinion and justifies his/her views. In the third stage, in the "Example", the student reinforces his/her theoretical idea with practical evidence, real-life examples, experiments or scientific data. The final stage, "Generalization," combines all the ideas and draws a general conclusion.
In the process of independent work, the FSMU method can be used in writing essays and abstracts, analyzing the results of laboratory work, preparing answers to problem questions, covering controversial topics, and completing practical exercises. For example, in chemistry, on the topic "The Importance of Catalysts in Chemical Reactions", the student first expresses his opinion on the importance of catalysts, then explains the reasons for this, gives examples of reactions, and finally draws a general conclusion. This method forms the skills of independent decision-making, defending one's point of view, analytical approach, and scientific thinking in

students. At the same time, the FSMU method also helps to improve students' speech culture, written literacy , and creative activity. Application form in MI:

Table 1. **Application of the "FSMU" method in MI**

Component	Content	Inorganic chemistry example
Opinion	The student's main idea	"Metals conduct electricity well"
Reason	Justification of the idea	"They have free electrons in their outer layer"
Example	Example to support the idea	"Copper, aluminum, iron are good conductors"
Generalization	Conclusion	"The electrical conductivity of metals is related to their structural properties"

When completing an MI assignment, the student expresses his/her thoughts in writing in the form of FSMU. This method develops the student's ability to think logically and express his/her thoughts in a well-reasoned manner [9].

The "Insert" method is a method of analyzing the read text based on a system of symbols [3]. The procedure for using MI is that the student places the following symbols on the read text (textbook paragraph, scientific article, manual section):

· "V" — I know that;
· "+" — new information;
· "–" — a different opinion, contrary to what I know;
· "?" — unclear , additional information is needed.

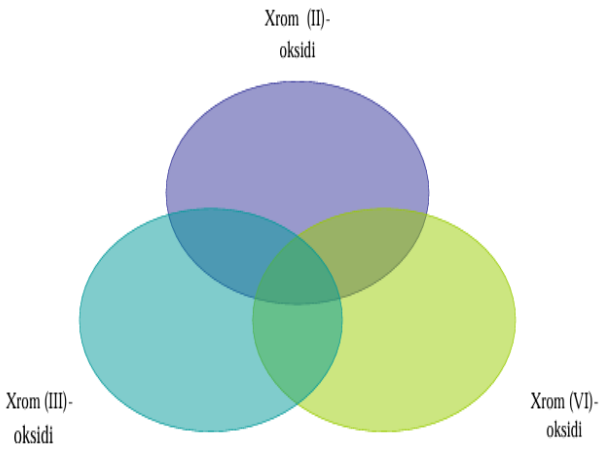
Based on the marked text, the student fills in the following table:

I know (V)	New information (+)	Disagreement (–)	Incomprehensible (?)

" Insert " method in the student critical thinking develops , learns the material deep analysis to do and own knowledge new information with comparison skill [10].

Graphic organizers — education material visual in the form systematizer and analysis doer are tools [8]. Graph organizers — education material visual apparently to express , to systematize and analysis to do service doer effective pedagogical tools They are students the topic deeper understanding , basic concepts between connections to determine and independent thinking skills to develop help Independent work " Cluster " method in the process using to the topic related main idea and concepts grouping , " Venn via " diagram " similar and different aspects comparison , "" BBB " table through I know , I want to know. and I knew stages determination and " Insert " technology based on text on active work graphic organizer using problem and his/her the reasons analysis to do recommendation These organizers increase the efficiency of easy assimilation, memorization, and logical analysis of educational material . The following graphic organizers are recommended for use in MI:

The "Cluster" method is a method of writing related concepts around a main concept in the form of branches. The "Cluster" method is one of the effective interactive methods that serves to visually represent, systematize and analyze educational material. In this method, the main concept or topic is written in the center , and related thoughts, ideas, terms and concepts are placed in the form of branches or branches. As a result, the general structure of the topic is formed , and the logical connections between concepts are clearly demonstrated. During clustering, students distinguish between the main and secondary concepts of the topic, identify similarities and differences between them, and learn to arrange information in a logical sequence. This serves to develop analytical and critical thinking skills. The cluster method can be performed individually, in pairs or in groups , and also forms the skills of students to work together, exchange ideas and justify their point of view.



The Venn diagram method is a method of comparing and contrasting two or three concepts. This method is mainly in graphical form, and is used to summarize the results obtained and draw a single conclusion from them, to compare, analyze and study two or more objects (appearance, fact, concept). The diagram is formed by the intersection of two or more circles. For example, it is used in the study of topics such as "Ionic and covalent bonding", "Metals and non-metals", "Types of oxides".

"Sinquain" is a brief description of a topic in the form of a five-line poem. The "Sinquain" graphic organizer is one of the interactive methods that helps students express the content of the topic in a short, clear and creative way. This method is composed in the form of a five-line poem and helps to summarize the main content of the topic. In the sinkquain, one main concept or word that expresses the topic is written in the first line, two adjectives that describe the topic are given in the second line, three verbs that express actions related to the topic are written in the third line, a four-word sentence expressing the author's opinion on the topic is composed in the fourth line, and a synonym or conclusion that summarizes the content of the topic is given in the fifth line . This method develops students' creative and logical thinking, forms the skills of isolating the main idea and expressing it briefly and meaningfully. The sinkquain method is effectively used in the process of independent work, consolidating the topic, repeating it , and drawing a final conclusion.

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Table 2. **Structure of the "syncwain" method**

ROW	CONTENTS	EXAMPLE
1	Subject (one word)	Water
2	Description (two adjectives)	Transparent, colorless
3	Action (three verbs)	It flows, evaporates, freezes.
4	Attitude (four-word phrase)	The source and basis of life
5	Synonym (one word)	H2O

"BBB" (I Know, I Want to Know, I Got It) is a comparison of a student's knowledge level at the beginning and end of the learning process [6]. The "BBB" (I Know, I Want to Know, I Got It) graphic organizer is one of the interactive learning methods that serves to identify students' prior knowledge on a topic, determine their need for new knowledge, and analyze the knowledge acquired at the end of the learning process. This method is usually organized in a tabular format and consists of three main columns. In the first column, "I Know," students write down their prior knowledge, facts , and information about the topic. This stage helps students activate their existing knowledge and increase their interest in a new topic. In the second column, "I Want to Know," students write down questions they are interested in about the topic and aspects they want to know . This process motivates students to research and learn independently. The third column, "What I Learned," is filled out at the end of a lesson or independent work, and students record new knowledge, concepts, and conclusions they have learned. In this way, the student monitors the change in his level of knowledge and assesses the extent to which he has mastered the subject. The use of the "BBB" method is especially effective in independent work, seminar classes, project work , and laboratory classes.

I know (B)	I want to know (B)	I found out (B)

What I knew before completing the MI assignment What I want to learn during the MI What I learned after the MI assignment

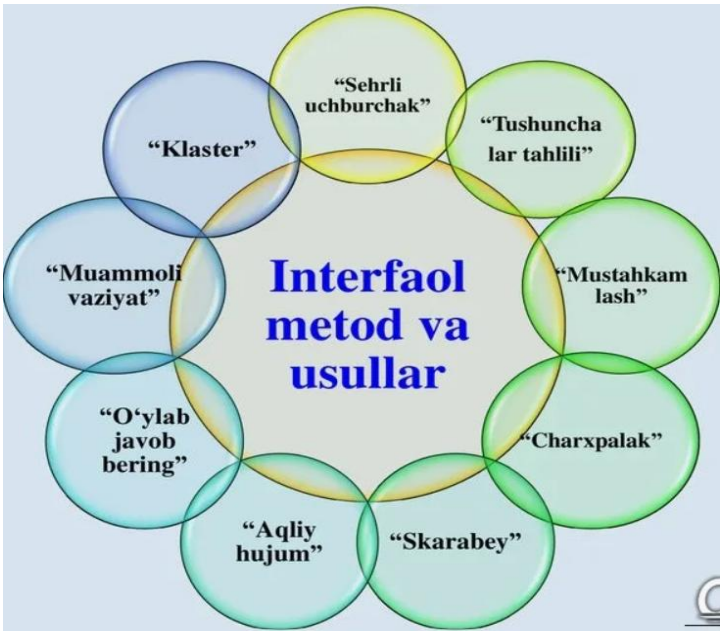
the above interactive methods and graphic organizers into MI from inorganic chemistry was carried out based on the following model [1]:

Table 3. **interactive methods and graphic organizers into MI**

MI stage	Interactive method/Graphic organizer	Purpose of use
Preparation (familiarization with the topic)	Insert, BBB	Determining prior knowledge, planning learning
Learning (mastering the material)	Cluster, Venn diagram	Reflecting connections between concepts
Analysis (in-depth analysis of the material)	FSMU	Identifying cause-and-effect relationships, drawing conclusions
Reinforcement (reinforcing knowledge)	Ferris wheel, Boomerang	Peer review and evaluation, repetition
Conclusion (presentation of results)	Sinkwain	Give a brief summary of the topic

Interactive methods and graphic organizers are effective tools for activating students' independent work in inorganic chemistry. Interactive methods such as "Carousel", "Boomerang", "FSMU", "Insert" increase students' interest and motivation in MI , develop their skills in working together, teaching each other and assessing each other. Graphic organizers such as "Cluster", "Venn Diagram", "Fish Skeleton", "Sinkwein", "T-Table", "BBB" allow visual systematization, analysis and generalization of educational material. The proposed integration model involves the use of interactive methods and graphic organizers in accordance with each stage of MI.

The main goal of pedagogical experimental work is to experimentally verify and substantiate the impact of developed advanced methods (interactive methods, graphic organizers) on the effectiveness of students' independent work in inorganic chemistry [9, 11].



Interactive methods. The methods of "Carkhpalak" - mutual verification and evaluation, "Boomerang" - circular exchange of ideas, "FSMU" - idea, reason, example, generalization, "Insert" - text analysis with symbols were included in the MI tasks.

Graphic organizers. Graphic organizers such as "Cluster", "Venn Diagram", "Fish Skeleton", "Sinquain", "T-chart", "BBB" were used by students in completing MI assignments.

interactive methods and graphic organizers on MI effectiveness has been analyzed [7, 11]:

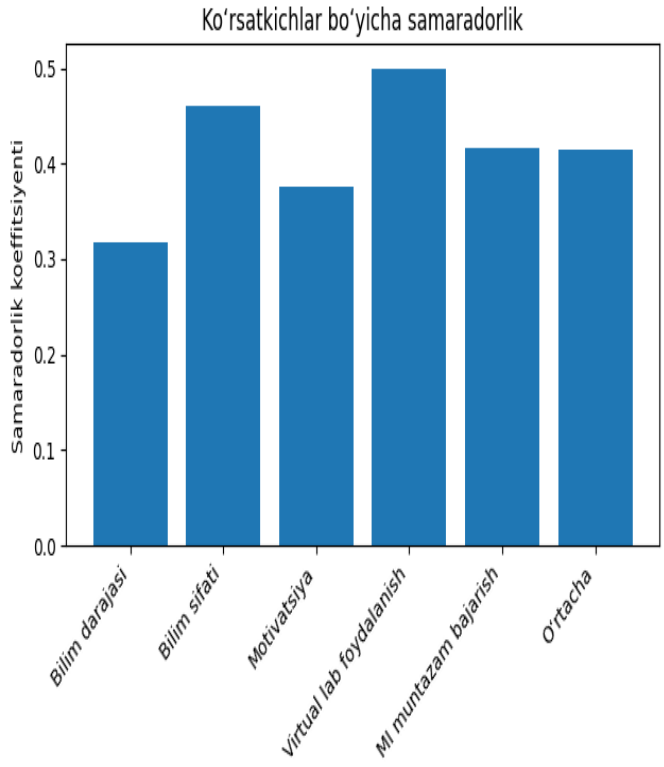
Table 4. **interactive methods and graphic organizers**

Method/Organizer	Frequency of application	Post-application mastery	Efficiency coefficient
"Carousel"	85%	84.5%	1.40
"Boomerang"	80%	82.3%	1.36
"FSMU"	78%	81.6%	1.34
"Insert"	75%	80.2%	1.32
"Cluster"	82%	83.1%	1.38
"Venn diagram"	76%	80.8%	1.33
"Fish skeleton"	70%	79.5%	1.31
"Cinquefoil"	68%	78.2%	1.29

All interactive methods and graphic organizers showed high efficiency with efficiency coefficients ranging from 1.29 to 1.40. The highest efficiency was observed in the “Carkhpalak” (1.40) and “Cluster” (1.38) methods.

Interactive methods and graphic organizers played an important role in increasing students' interest and motivation in MI. In particular, the “Carkhpalak” and “Cluster” methods showed the highest effectiveness.

The average efficiency coefficient of interactive methods and graphic organizers was 1.34 .



The average efficiency coefficient of the proposed methods was 0.414 (41.4%). This indicator indicates that the developed advanced methods are significantly more efficient (by 41.4%) than traditional methods [2 , 4].

The overall efficiency coefficient of the proposed methods was 0.414 (41.4 %).

These indicators indicate the positive impact of the proposed methods (interactive methods, graphic organizers) on increasing the efficiency of students' independent work in inorganic chemistry and the feasibility of introducing them into the practice of higher pedagogical institutions.

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