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Formation of critical thinking skills at the lesson of the discipline «Chemistry of Elements»

A methodology for conducting classes using new forms of work that promote the development of critical thinking has been developed. The first year students took part in the experiment. Pedagogical experiment consisted of three stages, namely, ascertaining, formative and control. Classes were held with the use of various techniques such as schemes, diagrams, presentations, clusters, which made the classes more interesting, cognitive and diverse. Questionnaires and questions for testing the level of components development of critical thinking were designed. They helped to determine the level of educational motivation and to test the effectiveness of supporting abstracts. These tasks were applied before the beginning of the experiment to determine the initial level of development of critical thinking, as well as after the formation stage. The results of the present stage of the experiment showed that the level of critical thinking of first-year students was not sufficiently developed. The obtained data of research can be used at creation of a technique of students' critical thinking development in the chemistry course teaching. In comparison with the traditional form of teaching, where an authoritarian approach to learning is used, this technology provides a free liberal form of conducting a lesson that leads to the awakening of students' cognitive activity. Traditional evaluation technique can be used to assess students when using new forms of work, since the components of critical thinking cannot be evaluated specifically. The technology helps to establish a discussion between students, through a form of work such as oral presentation.

Keywords: critical thinking, motivation, introspection, reflection, technology, Venn diagram, cluster, presentation.

Introduction

Lecture, seminar, practical classes, laboratory work, independent work of students are traditional forms of teaching chemistry in high school. Lecture is a basic form of teaching students. The main purpose of a lecture is to provide a theoretical basis for training, develop interest in the learning process and a certain academic discipline, and motivate students to develop self-directed activities during the course [1]. In addition, a lecture is a convenient way of obtaining the basic information in a compressed form, which activates the process of cognitive activity in practical exercises. All of these are a significant plus of lecture classes. However, it is possible to identify a number of disadvantages inherent in the lecture form of training, for example, getting involved in passive perception of the information received, inability to think critically, and almost complete absence of independent work. At the lecture classes the students do not try to comprehend the material, but simply mechanically write down the lecturer's information. This means that there is simply an imitation of the cognitive process. There is a need for a new format arises for conducting lecture classes to use the teaching time effectively, which is provided to familiarize students with new material by reading the lecture of a teacher.

Experimental

The pedagogical experiment was conducted on the discipline «Chemistry of Elements» in which the first-year students took part. The first-year students of the Kazakh department were chosen to participate in the experiment, because there are class-lesson forms of the organization of the educational process at schools, where students study subjects strictly sequentially in a specific volume for a certain period in classroom conditions. In the university, students are trained in the credit system of education, which is aimed at increase the level of self-education and individualizing the pace of student learning. Therefore, first-year students are the least prepared for an individual form of training organization, where they must independently master the knowledge. Also another reason why first-year students took part in the experiment is that at school students use one or two textbooks, when they come to the university, as such, they have no single textbook on which they can study. This is one of the difficulties in finding and studying information. One of the tasks of the experiment was that the students of the Kazakh department should learn to write lecture notes from textbooks not only in Kazakh, but in Russian too.

Before applying the technology of critical thinking at the lesson of chemistry, it is necessary to find out at what level of development critical thinking exists. Especially, in the first year students with a different level of education from different schools study. In this regard, the pedagogical experiment was divided into three stages, namely, ascertaining, formative and control. For each stage, various tasks were developed, which served as diagnostic and forming tools [2].

The goal of the ascertaining stage of the experiment is to determine the initial level of development of critical thinking among students in the process of teaching chemistry of elements. In accordance with the goal, the main tasks of the ascertaining stage of the experiment are outlined:

- to determine the level of motivational readiness of students for the formation of critical thinking in the process of studying the chemistry of elements;
- define criteria and indicators of the level of development of critical thinking of students;
- select the diagnostic material with which it's possible to determine the qualitative characteristics and are unique to each of the critical thinking levels;
- define the initial level of development of critical thinking in first-year students.

At this stage of the experiment, students' learning motivation was studied, also the ability to compose abstracts, and the ability to work in a group. A questionnaire [3] to study the motivation of students was used, where students were required to answer «yes» or «no» to the following questions:

- 1) Are you interested in studying chemistry?
- 2) Can you apply the knowledge gained in chemistry in life?
- 3) Do you ask questions to the teacher if you do not understand something?
- 4) Do you read additional literature on chemistry?
- 5) Do you like solving complex chemistry problems?
- 6) Are you interested in the achievements of scientists in the field of chemistry?
- 7) Are you trying to find answers to your questions?
- 8) Do you apply knowledge gained in chemistry classes while studying another subject?
- 9) Do you limit the information in the textbook to answer on the lesson?
- 10) Do you practice self-education?
- 11) Do you consider the information presented in the textbooks is interesting?
- 12) Do you think good knowledge will help you in your future professional work?

For each question with a «yes» answer, one point is awarded, with a negative answer, the points are not credited. Levels of motivation: high (from 10 to 12), medium (from 6 to 9), low (from 0 to 5).

It is possible to monitor positive changes in the students' educational motivation in comparison with the initial state after processing the results of the questionnaire (Table 1).

Table 1

The level of motivation of students before and after the experiment

Levels	Number of Students	
	before the experiment	after the experiment
High	6	7
Average	14	15
Low	4	2

As the results of the research show, the motivation of the majority of students at the beginning of the experiment is at an average level, where students' interest in the learning process is inactive and the activities of students are not meaningful, and then there are positive changes.

There are a huge number of techniques and strategies for students to develop their critical thinking. At the beginning of the study, we selected forms of independent work that contributed to the development of the ability to think critically, which would result in mastering the skills of presenting the results of our analysis in various ways such as writing a summary, a collective presentation, a Venn diagram and diagrams, clusters.

Writing and drawing up a summary before each lecture was offered to students at home. Students can use any sources of information that must be presented in the form of a lecture. The amount of information learned by students in self-writing notes, the degree of understanding of the material studied, as well as those questions and facts that students could not understand in the course of independent work were determined by asking leading questions. Preliminary acquaintance with the material through the drafting of the abstract first caused the students great difficulties. Therefore, at the initial stage of the application of this methodology, the independent writing of abstracts was organized. Mandatory requirements for the content of the abstract was a thesis of the theoretical material with the derivation of formulas, laws, questions arising during the study of the material, the availability of examples of practical application of the material [4].

Evaluation of the abstracts was organized as follows. Four groups of students were trained, who were trained to write abstracts, according to the following criteria:

- there is no abstract;
- the abstract is not complete (not all material is reflected in the abstract);
- the summary is complete, but it has some drawbacks (the material is poorly structured, there are no conclusions, few examples, its attitude to the material is not shown in the form of questions, additions);
- the abstract is mostly without shortcomings. Improvements in learning outcomes were recorded.

When comparing the results of the study of preliminary processing of educational material, one can observe an increase in the number of students whose abstracts are mostly deficient, which leads to the development of the capacity for self-organization and critical analysis of one's own activity (Table 2).

Table 2

The results of the evaluation of abstracts before and after the experiment

Evaluation Criteria	Number of Students	
	before the experiment	after the experiment
There is no abstract	2	0
Abstract is incomplete	11	8
Abstract is complete	7	7
Abstract basically has no shortcomings	4	9

To assess the effectiveness of the compiled abstracts, we conducted a test work, where students had to answer a series of questions on the topic, using only their own abstracts. Within 10 minutes, using their own notes, the students had to answer the following 6 questions:

- 1) Why, in comparison with other elements of the VA group, the maximum valence of nitrogen in compounds is III, whereas, for example, the maximum valence of phosphorus is V?
- 2) Why does molecular nitrogen show a low reactivity?
- 3) What single oxide can be obtained by direct interaction of nitrogen and oxygen at high temperatures?
- 4) What reaction underlies the use of hydrazine as a rocket fuel?
- 5) Why is nitric acid stored in dark bottles? What reaction equation underlies this storage condition?
- 6) The most common nitrate, which is used as a nitrogen fertilizer?

Verification work carried out at the end of the experiment showed also improvements in comparison with the ascertaining stage.

Presentation as a kind of educational retelling puts the task to convey from the perceived text the main thing, using the language means of generalized content transfer. It occupies a special place in the teaching of coherent speech and contributes to the improvement of general communicative skills: to disclose the topic, the main idea of the text, to plan the utterance, to improve the created text.

Presentation lasting about 15–20 minutes was prepared by students, who were previously divided into groups. For example, in the lesson on «Elements of Group V», where the main representatives are nitrogen and phosphorus, we used the oxidation states characteristic of these elements as a basis for dividing students into groups. If a student came across a card with a «+5», he was in a group that needed to characterize all the nitrogen compounds, where he exhibited an oxidation state of «+5».

In preparing the presentation, students were given the opportunity to use various sources of information, including their own abstracts.

From each group, 2 to 3 representatives were elected who were to go to the board and provide information about the element, its representatives, properties and applications. After their speech, students from other groups asked them questions on interesting or incomprehensible facts.

The main requirements for the presentation were: own critical analysis of information, close communication with the audience, persuasiveness and creative submission of information using examples. The greatest number of skills and competencies helps to get work on a collective presentation, as apart from analytical abilities, the ability to distribute duties, skills of effective oral presentation is also developed.

Also one of the new forms of work was the development of schemes (Fig. 1).

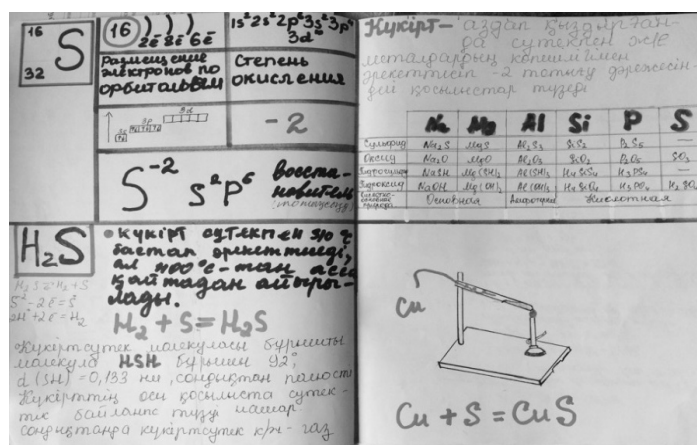


Figure 1. Presentation of the training material in the form of a schema

The scheme is used to visually structure a topic, highlight the main structural elements and establish links between them. These schemes help students to see not only the distinctive features of objects, but also allow faster and stronger storage of information [5].

The Venn diagram was used to compare two or more elements that have similar physical and chemical properties. The lesson reveals two or more concepts, terms, phenomena that need to be compared. For example, in the task «Compare properties and structure that are inherent in nitrogen and phosphorus», students draw rings, fill in graphs. At the stage of reflection, the diagrams in the groups are discussed (Fig. 2).

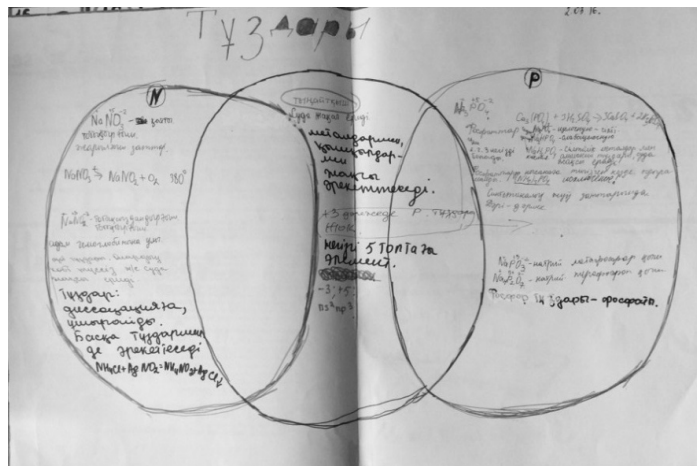


Figure 2. Venn diagram on the subject «Elements of the VA group»

Another of the new forms of work was the reception of Clusters. On the lesson, we tried to characterize the s-elements. Students had to write in notebooks all the associations that they cause these metals (work within 2 minutes). The teacher builds clusters on the board according to the ideas expressed by the students (Fig. 3).

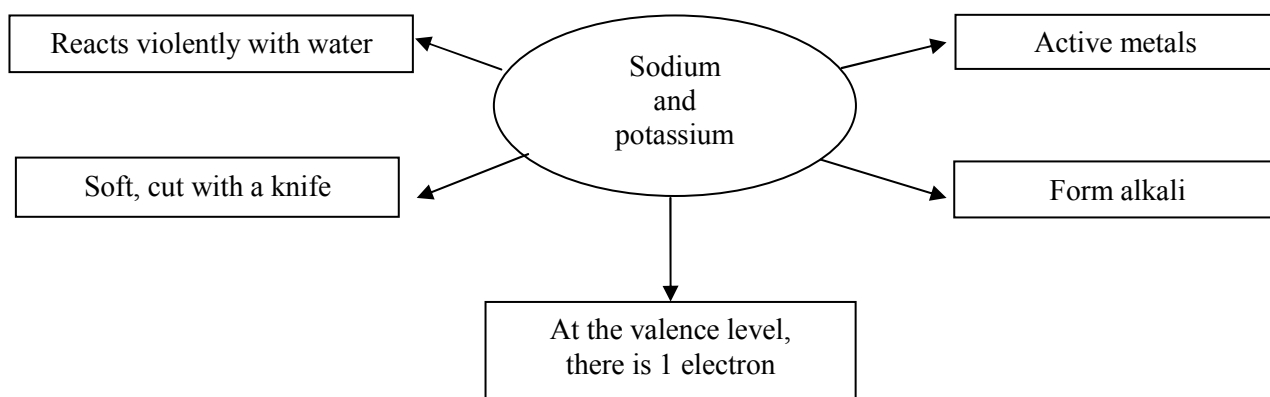


Figure 3. Cluster on «Sodium, potassium and their properties»

At the end of each lesson, students were asked questions for self-analysis of the effectiveness of their own abstracts and their participation in the work of the group when applying the presentation of the material.

- 1) Has your reference abstract helped you in answering questions on the topic of the lecture?
- 2) Do you think that the teaching material is fully reflected in your abstract?
- 3) Do you think you have learned reflect the training material briefly and at the same time fully?
- 4) Do you participate in the preparation of the group for the presentation?
- 5) Do you present your thoughts aloud when discussing a group of questions of a lecture?
- 6) Do you participate in the distribution of roles and the definition of the function of each member of the group?
- 7) Do you like the pace of the work of the group you were assigned to?

For clarity, the results of the study of the effectiveness of the abstracts are presented in the form of a diagram in Figure 4.

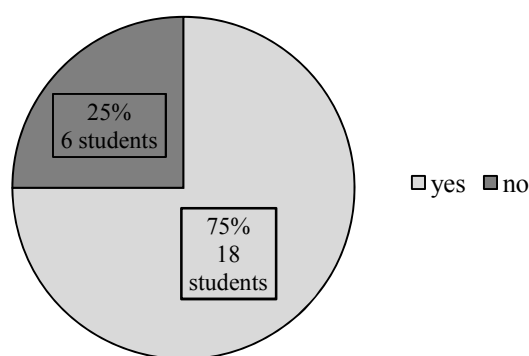


Figure 4. Efficiency of abstracts

The number of students who believe that the quality of their abstracts had improved markedly increased. Perhaps this was due to the fact that the number of students who believed that they had coped well with the questions of verification work had increased.

After processing the results of the questionnaire, the following data were obtained: 79 % of students rate their learning activity in the group as high, 21 % — as low.

On the last lesson we held a reflection in order to identify students' perception of new forms of work. For this purpose, students were given questionnaires with the following questions [6]:

- 1) Did you like the new forms of work with information?
- 2) Did you easily manage to present information in the form of diagrams, diagrams and presentations?

3) Do you think that these forms of work contribute for improving the quality of knowledge in this discipline?

4) Would you like to continue using these forms of work in class?

The results of this survey are shown in Figure 5.

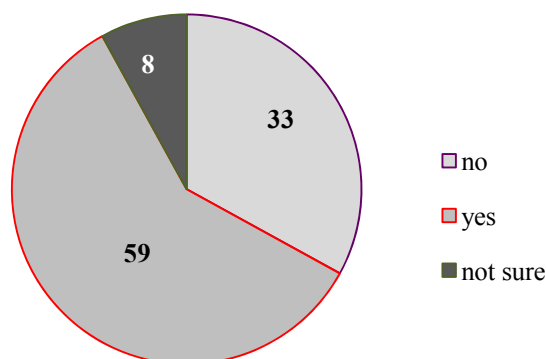


Figure 5. Perception of new forms of students work

Conclusions

Approbation of methods for developing students' critical thinking (abstract, clusters, schemes, Venn diagram and presentations) has proved the possibility of purposeful development of critical thinking of first-year-students in the process of teaching chemistry. The most difficult for the students was the task — the Venn diagram and the preparation of lecture notes. By the end of the experiment, students have learned to compose such abstracts that can be used in practical exercises without resorting to additional sources.

The results of testing all components of critical thinking at the control stage confirm the success of the experiment. Also, these techniques help to interest more passive students, who in the course of time in the process of learning may appear personal functions, in particular, motivation for learning. When applying these strategies independence of judgments, creative abilities are developed. If the teacher uses these techniques in the educational process, they can also identify individual gaps in the knowledge of each student.

It is necessary to use different methods and techniques to develop critical thinking among students not only in lectures, but also in practical exercises.

A small disadvantage of this technology is the teacher's time spent preparing for the lesson, since there are almost no didactic or teaching aids, which give examples of ready-made assignments that could be used to prepare the lesson plan. All the tasks the teacher needs to think through independently and to foresee questions that can raise doubts among students.

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Г.Т. Кокибасова, А.Т. Дюсекеева, С.Х. Казтаева

«Элементтер химиясы» пәні бойынша сабақтарында сын тұрғысынан ойлау қабілеттерін қалыптастыру

Сын тұрғысынан ойлауды дамытуға ықпал ететін жаңа жұмыс түрлерін қолданатын сабақтарды өткізу әдістемесі жасалды. Экспериментке бірінші курс студенттері қатысты. Педагогикалық тәжірибе үш кезеңнен тұрды: анықтау, қалыптастыру және бақылау. Сабақтар әр түрлі әдістерді қолданумен өткізілді: схемалар, диаграммалар, презентациялар, кластерлер, олар сабақты қызықты және когнитивті етуіне ықпал етті. Сыни тұрғыдан ойлау компоненттерінің даму деңгейін тексеру үшін сауаттылықты дамытудың деңгейін анықтау және рефераттардың тиімділігін тестілеу сұрақтары бойынша сауалнама өткізілді. Бұл міндеттер эксперимент басталғанға дейін сыни ойлаудың бастапқы деңгейі, сондай-ақ қалыптасу кезеңінен кейін анықталды. Тәжірибенің қазіргі кезеңінің нәтижелері бірінші курс студенттерінің сын тұрғысынан ойлау деңгейі жеткіліксіз дамығанын көрсетті. Зерттеудің алынған деректерін химияны оқыту барысында студенттердің сыни ойлауды дамыту әдісін құру кезінде қолдануға болады. Оқудың авторитарлық әдісі қолданылатын дәстүрлі оқыту әдісімен салыстырғанда, бұл технология оқушылардың танымдық белсенділігін оятуға әкелетін сабақты өткізудің еркін либералды нысанын қамтамасыз етеді. Оқушылардың жаңа жұмыс формаларын пайдаланған кезде бағалау үшін дәстүрлі бағалау әдісін қолдануға болады, себебі сыни ойлаудың компоненттері нақты бағалануы мүмкін емес. Технология ауызша презентация сияқты жұмыс түрлерімен студенттер арасында пікірталас құруға көмектеседі.

Кілт сөздер: сын тұрғысынан ойлау, мотивация, өзін-өзі талдау, рефлексия, технология, Венна диаграммасы, кластер, презентация.

Г.Т. Кокибасова, А.Т. Дюсекеева, С.Х. Казтаева

Формирование навыков критического мышления на занятиях дисциплины «Химия элементов»

Разработана методика проведения занятий с применением новых форм работ, способствующих развитию критического мышления. В эксперименте принимали участие студенты первого курса. Педагогический эксперимент состоял из трех этапов: констатирующего, формирующего и контрольного. Занятия проходили с применением различных приемов: схемы, диаграммы, презентации, кластеры, которые делали занятие более интересным, познавательным и разнообразным. Для проверки уровня развития компонентов критического мышления были разработаны анкеты для определения уровня развития учебной мотивации и вопросы для проверки эффективности опорных конспектов. Данные задания применялись перед началом эксперимента для определения исходного уровня развития критического мышления, а также после проведения формирующего этапа. Результаты констатирующего этапа эксперимента показали, что уровень критического мышления первокурсников недостаточно развит. Полученные данные исследования могут быть использованы при создании методики развития критического мышления студентов в процессе обучения химии. В отличие от традиционной формы преподавания, где используется авторитарный подход к обучению, данная технология обеспечивает свободную либеральную форму проведения занятия, которая ведет к пробуждению когнитивной деятельности студентов. Для оценивания студентов при использовании новых форм работы можно пользоваться традиционной методикой оценивания, так как компоненты критического мышления невозможно оценивать конкретно. Технология способствует установлению дискуссии между студентами посредством такой формы работы, как устная презентация.

Ключевые слова: критическое мышление, мотивация, самоанализ, рефлексия, технология, диаграмма Венна, кластер, презентация.

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