Artículo de investigación

The role of scientific and pedagogical heritage of G. Kamay in the formation of students' interest in chemistry

El rol de ciencia y pedagogical herencia de G. Kamay en la formación de los estudiantes en interés

O papel do património científico e pedagógico de G. Kamay na formação do interesse dos estudantes em química

Recibido: 20 de abril de 2018. Aceptado: 10 de mayo de 2018

Written by:
Farid Ja. Yambushev
Ulyana V. Mikhailova
Alla V. Evseeva
Kazan Federal University, Chemical Institute named after A.M. Butlerov
e-mail: info@ores.su

Abstract

The article presents the review of the use of scientific and pedagogical heritage of Gilm Khairevich Kamay (the representative of famous Kazan Chemistry School, Doctor of Chemical Sciences, Professor), for the development of schoolchildren interest in the study of chemistry. The urgency of this problem is determined by the need to use effective pedagogical and technological methods for activation the cognitive interest of students in chemistry, for better digestion of knowledge. The importance of this task is intensified as a result of the emerging contradictions between the increased theorization of school chemistry course, and the lack of close connection of the studied material with real life. The teacher has to use methodical methods for the formation of students' interest in chemistry, by means of realization the indispensible connection between learning and life. Information on the scientific and pedagogical activity of famous scientists, as the most important personal examples, should contribute to the growing interest of students in modern chemical discipline.

Keywords: phosphorus, arsenic, nitrogen, Kazan Chemistry School.

Resumen

El artículo presenta la revisión del uso del patrimonio científico y pedagógico de Gilm Khairevich Kamay (el representante de la famosa Escuela de Química de Kazan, Doctor en Ciencias Químicas, Profesor), para el desarrollo del interés de los escolares en el estudio de la química.

La urgencia de este problema está determinada por la necesidad de utilizar métodos pedagógicos y tecnológicos efectivos para activar el interés cognitivo de los estudiantes en química, para una mejor digestión del conocimiento. La importancia de esta tarea se intensifica como resultado de las contradicciones emergentes entre la mayor teorización del curso de química escolar y la falta de una estrecha conexión del material estudiado con la vida real. El docente debe utilizar métodos metódicos para la formación del interés de los estudiantes en la química, mediante la realización de la conexión indispensable entre el aprendizaje y la vida. La información sobre la actividad científica y pedagógica de científicos famosos, como los ejemplos personales más importantes, debe contribuir al creciente interés de los estudiantes en la disciplina química moderna.

Palabras clave: fósforo, arsénico, nitrógeno, Kazan Chemistry School.

Resumo

O artigo apresenta a revisão do uso do patrimônio científico e pedagógico de Gilm Khairevich Kamay (representante da famosa Escola de Química de Kazan, Doutor em Ciências Químicas, Professor), para o desenvolvimento do interesse de crianças em idade escolar pelo estudo da química.

A urgência deste problema é determinada pela necessidade de utilizar métodos pedagógicos e tecnológicos eficazes para ativar o interesse cognitivo dos estudantes em química, para uma melhor digestão do conhecimento. A importância dessa tarefa é intensificada como resultado das contradições emergentes entre o aumento da teorização do curso de química escolar e a falta de estreita conexão do material estudado com a vida real. O professor tem que usar métodos metódicos para a formação do interesse dos estudantes em química, por meio da realização da conexão indispensável entre aprendizagem e vida. Informações sobre a atividade científica e pedagógica de cientistas famosos, como os mais importantes exemplos pessoais, devem contribuir para o crescente interesse dos estudantes na disciplina química moderna.

Palavras-chave: fósforo, arsênio, nitrogênio, Escola de Química de Kazan.

Introduction

The representatives of Kazan Chemical School have always distinguished among other chemists due to their scientific discoveries. Among them an important place is occupied by the discovery of chemical element - ruthenium, made by Russian chemist K.K. Klaus in Kazan Chemical School. In addition to K.K. Klaus, such Kazan scientists as N.N. Zinin, A.M. Butlerov, V.V. Markovnikov, A.M. Zaitsev, F.M. Flavitsky, A.E. Arbuzov, B.A. Arbuzov, G.Kh. Kamay became famous (Arbuzov A.E, 1975; Mokshyn S.I, 1969; Galkina I.V, 2006). In 1842, an outstanding discovery was made by N.N. Zinin. For the first time ever he developed the technology of aniline synthesis by the reaction of nitrobenzene reduction, and opened the way to the aniline-ink industry. In 1861, A.M. Butlerov developed famous theory of chemical structure of organic substances. The name of A.E. Arbuzov is associated with the creation of new chemical branch of organophosphorus compounds. It was the basis for the chemistry of organoelement compounds. The reaction, named after A.E. Arbuzov, became a "high road" for the synthesis of organophosphorus compounds, and many of them were used in practice.

The world-famous "Arbuzov" School of Organophosphorus Chemists was founded in Kazan. The first and the best representatives of this School were the students of A.E. Arbuzov: B.A. Arbuzov, A.I. Razumov, V.S. Abramov, G.Kh. Kamay. Later G.Kh. Kamay developed the chemistry of organoarsenic compounds, A.N. Pudovik – the chemistry of organophosphorus compounds.

The aim of the research was to develop the methodological techniques for increasing students' interest in studying chemistry, with the help of information on scientific and pedagogical heritage of Gilm Kamay.

The object of the study was the 10th grade students.

The subject of investigation is the process of formation of students' interest in chemistry, on the basis of more complete realization of existing link between learning and life in the process of training.

Hypothesis: the study of chemistry is more effective when the student has an increased interest in subject, if the teacher can fully implement the principle of connection between learning and life in the process of training.

To achieve this goal and to obtain positive results, it is necessary to solve the following tasks:
1) to develop a set of measures, which can be used to create the opportunities for the formation of interest in chemistry;
2) to find means and methods for increasing the interest of schoolchildren in the study of chemistry;
3) to hold a quiz, and to make conclusions on the basis of testing.

Methods

The solution of above tasks includes the following measures:
- the analysis of methodological, psychological and pedagogical literature on the research problem;
- modeling of lessons, activating the interest in chemistry, on the basis of implementation the principle of connection between learning and life in the process of training;
- execution of the developed activities in planned sequence;
- the analysis and processing of the obtained research results.

To carry out the pedagogical experiment, the following research methods were used: observation and analysis of chemistry lessons in the 10th grade of the Municipal Budgetary General Education Institution "Nyryinskaya Secondary School named after M.P. Prokopiev" of the Kukmorsky Municipal District of the Republic of Tatarstan; individual conversations with students, written test papers, the analysis of students' answers in class.

Results

To achieve this goal, the following issued were prepared:

- information on the scientific and teaching activities of G. Kamay;
- questions for a quiz;
- test tasks;
- questions for the survey;
- tasks for the review work.

During the work in the experimental class, 7 chemistry lessons were conducted. A quiz, written works, conversations with students, questionnaires were conducted at the lessons, in order to evaluate the quality of knowledge.

The results of the review work on the topic "Comparative characteristics of saturated and unsaturated hydrocarbons" are presented in Table 1.

Table 1: Comparative characteristics of saturated and unsaturated hydrocarbons

Grades	Number of answers, in %
«5»	14,2
«4»	43,1
«3»	28,5
«2»	14,2

To estimate the effectiveness of proposed approach, we conducted testing, the results of which are given in Table 2.

Table 2: Effectiveness of proposed approach

Grades	Number of answers, in %
«5»	28,6
«4»	42,8
«3»	28,6
«2»	-

The diagrams, showing the level of chemical knowledge digestion, after implementation of various approaches in teaching of chemistry, are presented below.

The results of review work, in%

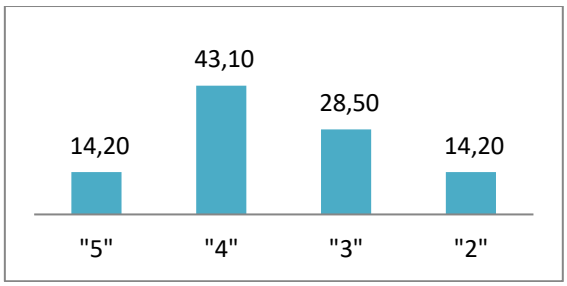

Figure 1: The results of review work, in%

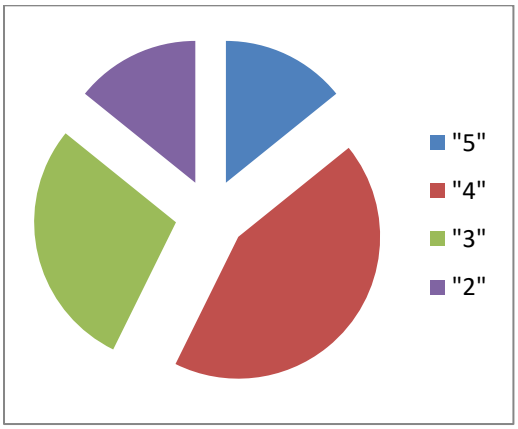

Figure 2: The result of review work

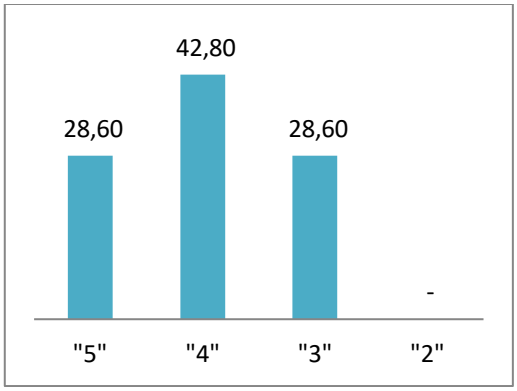

Figure 3: Testing results, in %


Figure 4: Testing result

Discussion

Chemistry, being the basis of life, plays a crucial role in understanding life processes and is the main subject for studying in the school course. However, under the influence of objective and subjective factors, the interest of modern students in chemistry in general schools has decreased. There is a contradiction between the growing importance of chemical knowledge for modern man and the lack of understanding the importance of studied material for practical life. The negative consequences of this trend will lead to a shortage of workers and specialists in the chemical industries.

Chemistry is considered as one of the difficult subjects in modern school. However, when a student has an interest, then there is keenness, enthusiasm, learning brings pleasure. The formation of such an interest may be influenced by the study of scientific heritage of Doctor of Chemical Sciences, Professor Gilm Khairevich Kamay (Lozovoy A.S, 1982; Lozovoy A.S, 1984).

- ***Information on scientific and teaching activities of G. Kamay.*** G. Kh. Kamay worked in the field of chemistry of organic compounds of the fifth group elements of Mendeleev periodic system - phosphorus, arsenic and nitrogen. In this direction, more than 350 works were carried out and published in the press. He began scientific research in the field of organophosphorus compounds in 1926, under the guidance of Academician A.E. Arbuzov. In particular, he synthesized di-n-butyl ether of trichlorophosphoric acid, which is produced at one of the plants of our country under the name "chloro ether".

In the postwar period, the interest appeared in phosphorus-containing high-molecular compounds with specific properties, including incombustibility and self-quenching. A series of reports, made by G. Kh. Kamay, was published in the press. His studies were dedicated to the synthesis of various allylic derivatives of phosphorus acids, on the basis of which a number of polymers and copolymers with reduced flammability were obtained.

During the Great Patriotic War, G. Kh. Kamay for the first time in the USSR managed to develop the methods for the synthesis of highly toxic organophosphorus compounds and to synthesize the most effective of them – tabun and sarin.

The scientific works of G. Kh. Kamay in the field of organoarsenic compounds are globally known. He is the founder of scientific school on the study of organoarsenic compounds in the USSR. The contribution of G. Kamay to this field of chemistry is evidenced by the fact, that more than 290 esters of arsenic acids (from 550 known) were synthesized and investigated by G. Kh. Kamay.

Along with theoretical research, G. Kh. Kamay investigated the synthesis of organoarsenic compounds of applied significance. Under his leadership, substances with insecticidal and fungicidal properties were obtained; promising components of antifouling paints were found to protect the bottom of ships.
In addition to the works listed above, in the field of synthesis of organic compounds, containing phosphorus and arsenic, Professor G. Kh. Kamay is known for his extensive work on obtaining preparations, containing nitrogen. He conducts research on the development of nitro

compounds, which are used in reactive technology and the industry of ammunition.

Dozens of original syntheses have been developed, with the help of which several new ammunition and preparations for industry have been obtained. The most significant works of G. Kh. Kamay were in the field of reactive technology.

Professor G. Kh. Kamay combined successfully his scientific work with teaching activities, which began in 1921 (Gudkova V, 1962). Even during his studies at Tomsk University, he was the head of the children's home; he was a teacher in the Siberian Turkic-Tatar Pedagogical Technical School.

Since 1930, being an associate professor of Kazan Chemical Technological Institute, and then since 1931, being a professor, G. Kh. Kamay has been working as a teacher for chemical engineers, researchers and educators. He taught organic and special chemistry, brought up more than 40 candidates of science, 6 doctors of science. With the direct participation of G. Kh. Kamay, the specialty in chemistry and technology of intermediate products and dyes, as well as the department of organic synthesis technology were created in Kazan Chemical Technological Institute. He was the deputy director of Kazan Chemical Technological Institute twice, and from 1935 to 1937 he was a rector of Kazan State University (Gilm Khairevich Kamay, 2001; Sorokina T.D, 2004).

G. Kh. Kamay was always sensitive to somebody's grief. Being an orphan, he showed sincerely mercy to children, who had no parents. He could not be imagined only as a desk scientist, who knew nothing but formulas. The people, who knew Gilm Khairevich Kamay, always remembered him as kind, intelligent, benevolent and sympathetic. He was simple in dealing with people and always helped with pleasure. At the same time, he never relied on templates. He was the dialectic in the full sense of the word, and every conversation with him provided encouragement for creativity.
Gilm Khairevich Kamay was always surrounded by youth; he shared his knowledge generously with them. He encouraged young people to work harder. He said that work was the basis of all achievements and successes. G. Kh. Kamay writes that "talent without difficulty is like a car without wheels". Working openly, G. Kh. Kamay attracts followers, who twist their fortune with chemistry. His students were able to achieve success in science, due to the atmosphere of goodwill and exactingness, which was inherent to the school of Gilm Khairevich. Many of them emphasize that the decisive feature of the scientific school of G.Kh. Kamay was independency.

G. Kh. Kamay loved children. He always communicated with schoolchildren: he visited them and invited them to Kazan Chemical Technological Institute, where he worked, and personally took schoolchildren to chemical laboratories. His last gift for youth, the book "To meet the fate", he wrote racy and vividly (Kamay G.Kh, 1970; Lozovoy A.S. G. Kh, 1981). As if consulting with the reader, G.Kh. Kamay tells about himself, argues, opens the world of creativity, interesting and tempting.

- Development of a quiz to study the topic at school. Quiz – is one of the accessible and useful methodical forms of lessons. It is interesting, because it involves all participants in active work, raises the emotional tone, promotes better digesting of material. Educational value of the quiz lies in the fact, that it develops resourcefulness and interaction of students, broadens their outlook, promotes mental development, increases cognitive interest and creative sagacity, helps to reveal knowledge.

To conduct a quiz in the school, a jury is created, which evaluates the results of the answers. It consists of two teachers and two students from another class.

Before the start of the quiz, one of the jury members explain the students the order of the work. If it is conducted orally, the answers can be discussed. This gives the opportunity for students to consider their views. Written answers are put into the previously prepared box. The jury evaluates the results and decides the winners, sums up the quiz, emphasizing the most complete answers.

Table 3: Evaluates the results and decides the winners

	Quiz questions	Answers to the questions
.1	What chemical plants existed in the former Kazan province?	Kokshansky plant for the production of chrome salts; Krestovnikov brothers's soap factory; Bondyuzhsky chemical plant n.a. P.K. Ushkov; Kamsky soda plant n.a. I.V. Likhachev.
.2	List the products, manufactured by the plants of Kazan province.	Sulfuric, hydrochloric and nitric acids, calcinated caustic soda, papermaker's alum, chrome salts, blue and green vitriol, glycerin, stearin candles.
.3	When was the Kazan State University K(V)FU founded?	In 1804.
.4	What are the most significant discoveries of scientists of Kazan Chemistry School?	The theory of chemical structure of organic compounds was developed; new element of the periodic system was discovered; and organic compounds were studied.
.5	What was the scientist, who developed the theory of chemical structure of organic substances?	Alexander Mikhailovich Butlerov
.6	What was the merit of V.V. Markovnikov in the development of organic chemistry?	He explained the mutual influence of atoms in the molecules of compounds, established several important provisions, called the "Markovnikov rule." He opened a new class of hydrocarbons in the composition of the Caucasian oil
.7	What were the most outstanding Russian chemists of the second half of the XIX century?	A.M. Butlerov; D.I. Mendeleev; A.N. Engelgard; A.P. Borodin; V.V. Markovnikov; N.N. Beketov.
.8	Name the scientists of Kazan Chemistry School.	K. Klaus, N.N. Zinin, A.M. Butlerov, V.V. Markovnikov, A.M. Zaitsev, A.N. Popov.
.9	What was the area of researches of Kazan Chemistry School scientists?	These were the researches in the field of organic chemistry.
.10	What were the years of life of G. Kh. Kamay?	1901 – 1970
.11	When and where did G. Kamay study?	In 1922 - 1926 Kamay studied at the Chemical Department of the Tomsk State University.
.12	Who was the scientific adviser of G. Kamay in KSU?	A.E. Arbuzov
.13	Who was the scientific adviser of G. Kamay in Germany?	At the University of Tübingen, Kamay underwent training at the laboratory of German chemist, Professor Jacob Meisenheimer.
.14	When did G. Kamay be a rector of KSU?	1935 – 1937
.15	The organic compounds of what elements were investigated by G. Kamay?	Organic compounds of phosphorus, arsenic and nitrogen.
.16	What was the element, the compounds of which G. Kh. Kamay developed and recommended as insecticides and fungicides?	Arsenic

.17	What was the element, the organic compounds of which were used in reactive technology?	Nitrogen

- Test control of knowledge

1. What chemical element was discovered in Russia?
A. Mendelevium
B. Kurchatovium
C. Ruthenium
2. Who discovered the theory of chemical structure?
A. Butlerov
B. Zaitsev
C. Arbuzov
3. Who is the founder of the School of Organophosphorus Compounds in Russia?
A. Razumov
B. Markovnikov
C. Arbuzov
4. When was the Periodic Table of Elements of D.I. Mendeleev discovered?
A. In 1852
B. In 1869
C. In 1804
5. Name the city where G. Kh. Kamay (the founder of the School of Organoarsenic Compounds) was born.
A. Aktanysh
B. Tetyushi
C. Kazan
6. Where was the university, in which Kamay studied?
A. Tomsk
B. Kazan
C. Ufa
7. Who was the scientific adviser of G. Kamay during his postgraduate education?
A. Tronov
B. Arbuzov
C. Zinin
8. Where did Kamay work after postgraduate study?
A. In England
B. In France
C. In Germany
9. How long did Kamay stay abroad?
A. 2 years
B. 5 years
C. 1 year
10. When was Kamay appointed to the position of KSU rector?
A. In 1935
B. In 1933
C. In 1937
11. The compounds of what elements were studied by G.Kh. Kamay, except the arsenic compounds?
A. Sulfur
B. Nitrogen
C. Chlorine
12. When did Kamay defend his doctoral dissertation?
A. In 1939
B. In 1951
C. In 1941
13. Working on the compounds of this element, Kamay received substances with insecticidal and fungicidal properties. What was the element?
A. Arsenic
B. Phosphorus
C. Nitrogen
14. The compounds of this element, synthesized by Kamay, found their application in reactive technology? Name the element.
A. Arsenic
B. Phosphorus
C. Nitrogen
15. When did Kamay begin his teaching activities?
A. In 1930
B. In 1921
C. In 1935
16. What educational institution is associated with G. Kh. Kamay, except KSU.
A. Kazan Chemical Technological Institute
B. Kazan State Agrarian University
C. Kazan State Medical University

Table 4: Answers

1.C	2.A	3.C
4.B	5.B	6.A
7.B	8.C	9.A
10.A	11.B	12.C
13.A	14.C	15.B
16.A		

Review work on the topic: "Comparative characteristics of saturated and unsaturated hydrocarbons"

1. Electronic structure of saturated and unsaturated hydrocarbons.
2. Physical and chemical properties of saturated and unsaturated hydrocarbons.

After these actions, a survey was conducted on the following issues:
1. How do you think, whether your cognitive interest in the studied material has appeared?
2. What material do you remember when studying today's topic?
3. What is the most interesting form of the activity at the lesson?

The first question was answered positively by 68.9% of students. The issues, concerning the training activity of G. Kamay (36.8%) and the development of chemical science in Kazan (27.3%) turned out to be the most interesting for students. The quiz was the most interesting form of the lesson for majority of the students (63.1%).

Summary

The results of conducted activities make it possible to conclude that the material, developed by us, provides an improvement in the level of students' knowledge digestion.

Conclusions

It is useful to link learning materials with information about the life and work of outstanding scientists, who have made significant contribution to the development of chemical science, in order to increase the effectiveness of learning process during chemistry lessons.

Acknowledgements

The work is carried out according to the Russian Government's Program of Competitive Growth of Kazan Federal University.

References

Arbuzov A.E. (1975). Selected works on the history of chemistry. - Moscow: Nauka.
Galkina I.V. (2006). Useful supplements to the school course of organic chemistry. – Textbook for students-teachers and school teachers. – Kazan.
Gilm Khairevich Kamay. (2001). Bibliographic review, 1901-1979. - Kazan: Publishing house of Kazan .
Gudkova V. (1962). An enviable fate / In the collection: For the happiness of people. - Kazan: Tatgosizdat.
Kamay G.Kh. (1970). To meet the fate. - Moscow: Sovetskaya Rossiya.
Lozovoy A.S. (1984). The address of discovery is Kazan. - Kazan: Tatar Book Publishing House.
Lozovoy A.S. G. Kh. (1981). Kamay is a prominent Soviet scientist and public figure. Kazan.
Lozovoy A.S.(1982). Amirkhanova N.N. Gilm Kamay. - Kazan: Tatknigoizdat.
Mokshyn S.I. (1969). The Arbuzov Dynasty. - Moscow: Sovetskaya Rossiya.
Sorokina T.D. (2004). Stars of Kazan Chemistry School // Journal Kazan.