VISÃO GERAL DE PECULIARIDADES DE ENSINO DE CIÊNCIAS NATURAIS E QUÍMICA NA SEGUNDA METADE DO SÉCULO XIX E NO INÍCIO DO SÉCULO XX NA GEÓRGIA

OVERVIEW OF PECULIARITIES OF NATURAL SCIENCE AND CHEMISTRY TEACHING IN THE SECOND HALF OF NINETEENTH AND IN EARLY TWENTIETH CENTURY IN GEORGIA

ბუნებისმეტყველების და ქიმიის სწავლების თავისებურებების მიმოხილვა მეცხრამეტე
საუკუნის მეორე ნახევრის და მეოცე საუკუნის დასაწყისის საქართველოში

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RESUMO

O artigo descreve os programas educacionais e métodos de ensino de Ciências Naturais e Química na segunda metade do século XIX e início do século XX na Geórgia. O autor descreve as abordagens pedagógicas da época. Os conteúdos programáticos do período relevante são definidos e os paralelos são feitos com os programas modernos. O documento também demonstra a atitude em relação às práticas de laboratório do período mencionado.

Palavras-chave: *História da química, Didática da química, programas educacionais, métodos didáticos.*

ABSTRACT

The paper describes natural science and chemistry educational programs and teaching methods in the second half of nineteenth and early twentieth century in Georgia. The author describes teaching approaches of that time. Subject programs of the relevant period are defined and parallels are made with the modern programs. The paper also demonstrates the attitude towards lab practices of the mentioned period.

Keywords: *History of chemistry, Didactic of chemistry, educational programs, teaching methods.*

რეზიუმე

სტატიაში აღწერილია მეცხრამეტე საუკუნის მეორე ნახევრის და მეოცე საუკუნის დასაწყისის საქართველოში ბუნებისმეტყველების და ქიმიის სასწავლო პროგრამები და სწავლების მეთოდები. ავტორების მიერ გაანალიზებულია სწავლებისადმი მაშინდელი მიდგომები. აღწერილია შესაბამისი პერიოდის საგნობრივი პროგრამები და გავლენულია პარალელები თანამედროვე პროგრამებთან. ნაჩვენებია აღნიშნულ პერიოდში დამოკიდებულება ლაბორატორიული მეცადინეობების მიმართ.

საკვანძო სიტყვები: *ქიმიის ისტორია, ქიმიის დიდაქტიკა, საგანმანათლებლო პროგრამები, სწავლების მეთოდები.*

INTRODUCTION

HISTORICAL REVIEW OF THE PERIOD

In early XIX century, the Russian empire annexed Georgian kingdoms, thus destroying centuries-old Georgian statehood. Educational, cultural and religious institutions were meant to become a powerful weapon of Russification. The school was considered the most effective means of all. According to one of the empire's ideologist, F. Gershelman: "For the purposes of russification of the region (Georgia), the school should be able to bring up the youth with Russian spirituality, which is rather more difficult, than proper teaching of Russian language and grammar..." (Gershelman, 1908; Nikoladze, 1931).

Teaching in Russian language made it especially difficult to study the subjects of precise and natural sciences. This problem is also emphasized by a famous Georgian chemist, the first rector of the Tbilisi University – Peter Melikishvili, living at the edge of XIX-XX centuries: "...The teachers of natural science and mathematics would satisfy themselves only by giving lessons from text books and if we consider that the majority of students did not master or had poor knowledge of Russian language, than it is easier to imagine what scientific training was given by the school (gymnasium) to its students" (Suladze, 1965).

REVIEW OF EXISTING PROGRAMS ACCORDING TO THE DOCUMENTATION OBTAINED FROM THE FUNDS

In the second half of 19th century, natural science was taught from the primary level in elementary schools of Georgia. The analysis of educational programs of this period identified the key didactic methods, used as the basis for teaching the elements of nature and this process had more or less systemic character. From the recommendations, given to school administration by local or central (imperial) educational supervisors, we can imagine the forms and contents of natural science teaching. Various recommendations and resolutions emphasize that the teaching in elementary classes should begin with introducing the nature based on examples and events children have direct contact with and can describe from their own experiences. The content and language of teaching should be simple and easy to

understand, should not contain difficult terms. Students are expected to rely on the knowledge and experience gained from previous lessons. Teachers should show the students how the knowledge of nature is linked with the life and activities familiar to them. For example: knowledge of nature and natural phenomena in rural schools should be related to farming - garden activities, vine clipping, discharging dried branches from young plants, etc.

Natural science teaching program in elementary classes is designed so that to focus not on the system of knowledge transfer, but on the teaching of main sections/fragments – "The student should be able to see and touch what he/she is studying" (Archive fund 422, Descr. 6. 1895).

One can often find "Natural History" in the subject lists kept in other archival funds, this subject is also included in the list of exams of February 21st, 1881, published by the Tbilisi Classical Gymnasium (Archive fund 43, Descr. 1.). The same subject was taught at the Tbilisi Women's Gymnasium from the third grade and 27 lessons were devoted to it (Archive fund 440, Descr. 1, 1869). It was also taught in the eighth grade at Tbilisi's real schools. "Chemistry" was also mentioned in the subject list of these schools. The subject was taught at extra hours in the sixth grade. The list of topics is kept in the class registry.

Methane, Ethylen, Acetylen, Aromatic Hydrocarbons and they Derivatives. Alcohols- Methanol, Ethanol, Glycerol; Aldehydes, Ketones, Carboxylic Acids-Formic acid, Acetic acid; Fatty Acids; Alkaloid- Nicotine, Caffeine, Morphine, Proteins;

For repetition: Oxides, Acids, Salts, Hydroxides, Potassium, Sodium, Copper, Beryllium, Strontium, Magnesium, Zirconium.

As it seems the material on inorganic chemistry was taught in the fifth grade at extra hours (Archive fund 463, Descr. 1, 1888). The gymnasium libraries used to buy interesting literature on the nature. Reportedly, the Tbilisi Boys' Gymnasium had acquired a magazine "Nature" in French (French was taught intensively along with Russian, Latin, German and Greek in every gymnasium or educational institution) As they say, on October 23, 1893, the Tbilisi Women's Gymnasium received literature in Russian, among them are series of magazines: Earth, Water and Air. Information about nature and ecology was provided in popular language in these books. (Archive fund

441, Descr. 1, Case 221, 1898).

It's noteworthy that the Nature and Natural Science was also discussed on other lessons. For example, control writing in Russian language held in the sixth grade at the Tbilisi Boys' Gymnasium in 1899 was about the topic - "Lomonosov and the Three Style Theory" (The name of the topic is literally taken from the archival material). Following the plan, in their works the students wrote on the influence of Lomonosov in natural science (Archive fund 460, Descr. 2, 1898).

In the curriculum of 1899, the third-sixth grade program of the Tbilisi Women's Gymnasium included the following: plants, animals, substances, substances in the nature (Archive fund 441, Descr. 1, Case 112). Morphology and system of granular plants was taught in the 3d grade Botany. The program indicates that such integration of these two subjects is essential for the diversity and empirical perception of teaching materials and content. The following topics are envisaged to be taught in the forth grade: a) Air –air heating, movement, composition; b) waters: composition, properties; c) changes occurring on the surface of the earth; d) mountains, their species; e) crystals-individual species, f) metals, their properties and species: gold, iron, silver, lead, tin; etc. The chemistry is presented in a separate section of the 5th grade natural science program. It is also mentioned that due to the lack of labs in most of the schools, the full range of studies, envisaged by chemistry program, can not be exercised. Therefore fragment teaching of chemistry had been an established practice that time. Various resolutions (reports of official departments, school administrations, etc) denoted that systematic teaching course of chemistry required fundamental improvement of school's material bases, arrangement of labs, implementation of security system, teachers' professional trainings, etc. Georgian and in general, the school network of the Russian empire at the edge of XIX-XX centuries could not even provide the prospect of solving these problems. In the 6th grade, department of Natural Sciences consists of three parts: Plant structure (anatomy), plant physiology and mineralogy. Descriptive part of the program emphasizes that quality teaching of the volumetric material and achievement of results are hindered by the deficiency of qualified teachers, as well as by the lack of weekly hours/load allocated for digesting the material- 3 hours a week is not sufficient for mastering the

program. For this reason, the program provides recommendation on shortening the topics in the section of mineralogy.

"Chemistry" appears in a subject list at the beginning of the twentieth century. In 1904, Caucasus Educational District published a teaching program approved by the Ministry of Education of the Russian empire, covering general issues. (Archive fund 422, Decr. 6, Case 9442).

History of chemistry from the ancient period; Chemical phenomena; Symbols and formula; Chemical equations; Law of conservation of mass; Law of conservation of energy; Law of periodicity; crystallography; Hydrogen, Oxygen, burning; oxyhydrogen gas, oxidation, oxides. Water, spring water, mineral water. Solutions, Identifying drinking water suitability; Water purification. Water distillation; Ice, Snow, Steam. Artificial ice, Quantitative analysis of water; Chemical formula of water; The Dissociation; The critical condition of gas; The Chlorine, Hydrochloric acid; Hydroxides, Salts, Hydrates, Halogens; Sulfur; Hydrogen sulfide, Sulfur anhydride, sulfuric acid; Nitrogen; The air its condition, Ammonia, Ammonium salts, Nitrogen compounds with halogens, oxides of nitrogen; Nitric acid; aqua regia ; Phosphorus and its compounds; Carbon; The concept of organic chemistry; Oxygen compounds of Carbon; Silicon; Boron, Boric acid; Metals (Ca, Mg, Zn, Hg, Cu, Ag, Au, Al, Pb, Sn, Bi, Mn, Fe, Ni, Pt). Spectrum and spectral analysis, Spectroscope; The range of fire and sun rays; Sunscreen; The importance of chemistry in the industry.

The program of the Tbilisi Boys' Gymnasium is slightly different and refers to natural sciences (Archive fund 422, Decr. 1, Case 8484 and 8487).

The 6th grade: Air: concept, understanding, constituent parts of the air (gases) and their meaning: a)Oxygen: formation and key properties: combustion, breathing; b) Nitrogen: property-inertia, c) Carbon dioxide: formation and properties: Stiffness and inadequacy for burning, sources/basis of its existence (formation) in the nature. Soil as the source of plants' growth/feeding, Soil as a source of plant growth/power; A brief overview of plant's inner structures and basic vital functions: a) Cell and its constituents, chlorophyll, starch, sugar, essential oils, crystalline poisoning and medicinal substances. b)root, stem, leaf; c)Data on anatomical structure of human body: digestive system,

respiratory organs, blood and its circulation; breathing organs, excretory system, skin, sensory organs.

A letter to directors of educational institutions was found in the correspondence of a head of Educational-Regional Chancellery of Caucasus. The letter contains some kind of report on summer schools organized in Borjomi in 1911, 1912, 1913, 1914. The courses were about practical exercises in chemistry, physics, botany, zoology and physiology. It's worth noting that the subject of "physics" was taught along with "mathematics" in all gymnasiums and schools in the nineteenth century, but, as it seems, only theoretically. And now, the teachers were getting training on summer courses in order to conduct practical studies or laboratory works on lessons. The courses were approved by the Educational Process Control Agency of the Ministry of Education. A document issued by the Ministry reads that teachers working in educational institutions are graduates of seminars, institutes and universities, having scientific education, but along with the knowledge of the subject they should master teaching methodology of that subject. Otherwise, it will be impossible to teach the subject perfectly. Special attention was paid to class experiment, that differed from university tests for its simplicity, safety and purpose. Besides, for proper study of subjects of natural science it was necessary to organize excursions and visit various agricultural objects and get acquainted with the practice of applying the knowledge of natural science, including the chemistry, in production process.

Summer school program envisaged the following:

1. Lectures in the methodology of teaching natural science subjects, including discussions and exchange of opinions as well.
2. Laboratory works with entertaining and interesting experiments in chemistry, in physiology of humans and plants, anatomy, zoology and entomology. There were four groups of teachers who worked at different labs simultaneously, and then replaced each other.
3. Arranging training excursions in nearby areas. The participants were expected to gather rocks, minerals, plants, insects and next, to create study collections. The courses should start no later than May 1st and last in June/July. According to the order # 8292 of the Ministry of Education, 300 rubles were

allocated for these courses (Archive fund 422, Descr. 2, Case 142, 1911).

2. In the summer schools the teachers of the following educational institutions were actively involved: the Tbilisi Boys' Gymnasiums, Akhaltsikhe's six-year gymnasium; Khoni's six year gymnasium; Real schools of Tbilisi, Kutaisi, Sokhumi, etc. the Tbilisi Countess Vorontsova-Dashkova Gymnasium, women's gymnasiums of Batumi, Kutaisi, and Sokhumi. Tbilisi Big Kniagine Olga Feodorova Gymnasium. Tbilisi Big Kniaginie Ksenia Alexandrovna Gymnasiums. St. Nino Educational Institutions-in Tbilisi, Kutaisi, Telavi. The Tbilisi Alexandrovi Teachers' Institute. The Sokhumi Teachers' Seminar (Archive fund 422, Descr.2. Case 142, 1914).

After completing summer school courses, a Resolution #22291 was adopted at the session of the Ministry of Education of the Russian Empire, providing recommendation on opening museums of nature in every school, where the students would be able to receive additional knowledge. Lab trainings should be conducted at all schools. The Principle of Visualization should be carried out at such trainings and students would be given an opportunity to take part in practical activities and conduct small studies on their own.

3. Laboratory training should be conducted in a specially arranged room with special furniture and equipment (see Figure 1, room equipment for laboratory training). A drawing given on the picture according to which the Poti Romanov's Gymnasium ordered some items for laboratory classes, such as closet-tables, suction cupboard and water dispenser. Also, the gymnasium acquired learning resources, involved in chemistry/natural science - eg, tripod (Archive fund 441, Case 944, 1876).

The same Resolution reads that the studies should be conducted on the sixth lesson. Although the students would be tired at this time, the method of laboratory studies were different and the pupils would be able to relax and rest. The resolution also stated that teachers, who conducted such courses, would need additional remuneration and incentives. The teacher could also change the program and offer new interesting experiences to their students. Universities had to add the subject of

"Teaching Methods", so that teachers could get higher academic results using effective learning strategies (Archive fund 422, Descr.1. Case 12788, 1877). There was also indicated a following set of laboratory tests: oxygen production, absorption of nitrogen, carbon dioxide emissions, extinguishing the lamp in carbon dioxide, deposit formation in hard water, carbon dioxide disintegration. Algae inspection through microscopic slides, starch grains in potato bulb, beet juice and indicator, chlorophyll spirits. Osmosis. Iron sulfate penetration in parchment paper from tannin colloidal solutions. Water evaporation by leaves. Blood microscopic preparations.

Material for practical course: Shepansky-human body module. Fiedler and Geleman-anatomical tables. Human bodies made from papier mâché.

RESULTS AND DISCUSSION:

The archival material makes it clear that natural science and chemistry teaching was seriously taken care of in the period under study. Almost all modern programs are included in the programs found. However, the program of Tbilisi Real School also included the topic such as - "Alkaloids - Nicotine, Caffeine, Morphine" (Archive fund 422, Descr. 6. Case 9442). Although the material was intended for additional lessons, the time allocated for it could be used for rather more important topics. The review of programs makes it evident that environmental chemistry is especially emphasized. The program includes water types, pollution and treatment methods, air and its composition. The substances existing in the nature are taught separately. In addition, students were expected to study each issue in relation with the environment and life. In that period of course, there was certainly no such direction, as – ecological chemistry, environmental chemistry, green chemistry, home chemistry, however the programs offered many interesting topics from these directions to students. It's worth noting that schools/gymnasiums libraries were supplied with the appropriate extracurricular literature which also addressed the environmental chemistry. It is noteworthy that this additional literature was written in a very simple language that students could read and understand independently. In modern approaches, literature written in popular scientific language is of great

importance to the motivation of students and delivering material in a funny/easy-to-understand language.

In the beginning of the twentieth century, the subject of "chemistry" is clearly identified and the point at issue is the necessity of conducting laboratory works. The documentation also includes Summer Schools (similar to modern training) for teachers, where the method of conducting lab studies and training excursions are taught. It is absolutely right that the teacher may have a good knowledge of the subject but does not have a teaching method, so the study of methodology should also be mandatory in university education. A student must conduct an experiment at the lab training himself/herself (with the help of a teacher) and deepen his/her knowledge of the subject through simple discoveries. This approach is known in modern methodology as "learning-by-doing" and is still very relevant today. Thus, yet in early twentieth century, in Georgian educational institutions there were gradually introduced such productive teaching methods, which can be considered as conforming to modern concepts of teaching and learning. It is also important to equip the laboratories with furniture and the drawings on the presented figure look quite modern.

The idea of opening museums at schools is also especially remarkable. Chemical museums are actively used in teaching and ensure very good results (Domenici, V. 208).

CONCLUSIONS:

From the documents found, it's clear that on the verge of XIX-XX centuries, more or less attention was paid to the teaching of natural sciences. It is also noteworthy, that in different periods, the topics of various educational programs coincide with the topics of modern curriculum, however there are some dissimilarities as well, such as e.g: topic-alkaloids. In the indicated period, mention is made of organizing summer schools (modern training type) and the importance of laboratory training in chemistry and natural science teaching is also highlighted. The school museums are opened and it is acknowledged, that without proper methodology, full training of subject is not effective.

REFERENCES:

1. Gershelman, F. The causes of the turmoil in the Caucasus, **1908**, 59-62.
2. Nikoladze, N. Best Collection. V.1. Tbilisi. Iv.Javakishvili University Publishing House. **1931**, 29-31.
3. Tsuladze, E. Two Chemists. Tbilisi, **1965**, 37.
4. National Archives of Georgia, Historical Central Archive, fund 422. Description 6. Case 9442; Tbilisi real school. **1895**. Program of Elementary Classes- Natural Sciences (1,2,3 classes).
5. National Archives of Georgia, Historical Central Archive, fund 43, Description 1, Case 16. <http://www.archives.gov.ge/en/saistorioarqivi>
6. National Archives of Georgia, Historical Central Archive, fund 440, Description 1, Case 1245, Tbilisi Women's Gymnasium **1869**. <http://www.archives.gov.ge/en/saistorioarqivi>
7. National Archives of Georgia, Historical Central Archive, fund 463, Description 1, Case 1518, 1888/9, A statement on the training of students in additional classes of the Tiflis real school. <http://www.archives.gov.ge/en/saistorioarqivi>
8. National Archives of Georgia, Historical Central Archive, fund 441, Description 1, Case 2211, **1898**. <http://www.archives.gov.ge/en/saistorioarqivi>
9. National Archives of Georgia, Historical Central Archive, fund 460, Description 2, Case 314, **1898**. <http://www.archives.gov.ge/en/saistorioarqivi>
10. National Archives of Georgia, Historical Central Archive, fund 441, Description 1, Case 112. <http://www.archives.gov.ge/en/saistorioarqivi>
11. National Archives of Georgia, Historical Central Archive, fund 422. Description 6. Case 9442. <http://www.archives.gov.ge/en/saistorioarqivi>
12. National Archives of Georgia, Historical Central Archive, fund 422, Description 1, Case 8484. <http://www.archives.gov.ge/en/saistorioarqivi>
13. National Archives of Georgia, Historical Central Archive, fund 422. Description 1. Case 8487. <http://www.archives.gov.ge/en/saistorioarqivi>
14. National Archives of Georgia, Historical Central Archive, fund 422, Description 2, Case 142, **1911**. <http://www.archives.gov.ge/en/saistorioarqivi>
15. National Archives of Georgia, Historical Central Archive, fund 422, Description 2, Case 142, **1914**. <http://www.archives.gov.ge/en/saistorioarqivi>
16. National Archives of Georgia, Historical Central Archive, fund 441. Case 944. Tbilisi Gymnasium – **1876**. <http://www.archives.gov.ge/en/saistorioarqivi>
17. National Archives of Georgia, Historical Central Archive, fund 422, Description 1, Case 12788, **1877**. <http://www.archives.gov.ge/en/saistorioarqivi>
18. Domenici, V. J. of Chemical Education, **2008**, 85 (10), 1365.

Figure 1. The room equipment for laboratory training