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**METHODOLOGICAL GUIDELINES FOR SCHOOL CHEMICAL  
EDUCATION CONTENT UPDATE IN THE INFORMATION-  
SUBJECT ENVIRONMENT**

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*Abstract*

The article deals with didactic aspects of a new strategy for updating the content of school chemical education in the information-subject environment. Basing on the analysis of the didactic-methodical literature and best teaching practices of school education as well as taking into account world tendencies of development of system of science education, the authors identify reserves and resource update for the content of chemistry education and activities based on the principle of minimization. The research substantiates a new approach to updating the content of school chemical education on the basis of wide application of digital educational resources. It can be applied in the process in a special way organized educational activities under the condition for the use of a variety of chemical problems as an important component of learning content. The authors focus on the tasks of a pilot nature, which are considered as a tool of learning and understanding reality.

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**Keywords:** The Content of school chemical education, content of the training, the information-subject environment, digital learning resources, the principle of minimizing the content of the task at various levels, chemical experiment.



## 1. Introduction

Modern education is a leading socially valuable area of human activity and human values. It inextricably links the past, present and future in the development of society. The state of education in today's world is difficult and controversial. On the one hand, the introduction of the FSES (Federal State Educational Standard) in which the requirements to subject, metasubject and personal results of educational programs (The federal state educational standard of general education approved by the order of the Ministry of Education and Science of the Russian Federation dated 2010), on the other hand, minimization of school science education and the gradual replacement of the subject of Chemistry from the curriculum of the secondary school take place. The underestimation of the importance of natural Sciences in school curricula is in complete contradiction with their active demand. BSE (Basic State Exam) and USE (Unified State Exam) as a system of standardized tasks, can help to test the effectiveness of training on the stages of learning, consolidation, generalization and systematization of knowledge. However, "the cult of uniformity" always holds back the development of the talented and the original, i.e. the implementation of creative activity of pupils (Kartsova, 2016). In addition, BSE and USE take large financial resources. Educational sphere is very sensitive to any changes in social development. But it will have a substantial impact on the formation and development of certain social processes.

## 2. Research Questions

What is the relationship between pedagogical science and school practice? Corresponding member of the Russian Academy of Education Ivanova reveals the problems of interaction between theory and educational practice: "The Pedagogical knowledge, as knowledge is socially constructed, needs and responds to current trends of society development, socio-economic and socio-cultural objectives, basic trends of domestic policy, geopolitical circumstances, industrial processes and much more. However, like any other scientific knowledge, pedagogical knowledge must not only explain the existing reality, but also to predict the future, not only to evaluate the results of existing educational practices, but also to simulate new, relevant ideas about the future" (Basic Research Institute of Theory and History of pedagogy RAO, 2014). Revision of the main paradigm of education towards humanization stimulated innovative processes "human-like" character, the essence of which is to help the formation of "out of space items in space activities and life expectations" (Zinchenko, ). Is Russian pedagogics ready as a science to solve these theoretical and methodological problems? What should the subject teachers do if the "science is constantly changing, information is easy to find, so you need not to give information, but to teach the ways of its search" (Zhilin, 2011)? This idea reflects the historically established necessity of formation of the competitive personality and thus paradigm changes the role of the fundamental principles of subject didactics, turning them into the basis of the criterion of adoption of the addressable education and society decisions. Its development goes in the direction of a certain "21<sup>st</sup> century skills" the purpose of the competitiveness of graduates in the labour market. American researcher Wagner (2008) on the basis of a survey of hundreds of employers offered "seven survival skills", among them – critical thinking and problem solving.

### 3. Purpose of the Study

In the changed socio-economic conditions in which the need for a new person is actualized, the purpose of education is not so much science training for graduate school, as personal development, mastering of cultural experience of mankind, conscious of their place in society, able to continue their education in the future, to creative professional activity, self-determination, self-actualization, self-development. Chemistry is one of complex sciences; it is a key area of the economy. There is the request of the community for high-quality chemistry education in modern society. Studying chemistry at school should contribute to the formation of a holistic worldview of students towards scientific literacy and general culture.

The problem of updating the content and methods of teaching has always been and remains the center of attention of scientists-methodologists (Hayden, 2003). We investigated the conditions and mechanisms for updating the content of chemical education and activities in the information-subject environment on the basis of which was allocated to new units of learning content (Gerus, 2003), (Instrumental didactics, 2012), (Volkova, 2016); we consider the problem of integrating knowledge about the latest achievements of supramolecular chemistry and nanotechnology in the content of school chemical education (Volkova, 2016, 2016, 2016); investigated the effect of the information-subject environment on the formation of interdisciplinary skills and scientific literacy of school students in chemistry (Kuznetsova, Gerus, 2002), (Volkova, Tarakanova, 2016). All this has led us to the conclusion that the main objective of didactic research subject and technique becomes the transition to interdisciplinarity and transdisciplinarity as a main methodological reference points when designing new content and teaching methods.

### 4. Research Methods

Analysis of normative documents on general education, programs, educational and methodological literature; Analysis of the results of scientific research processes occurring in society and education; Questioning of teachers and students; Approbation of research results in school practice.

### 5. Findings

In school practice in accordance with three levels of learning there are three types of assignments:

- tasks of the first level (familiarity, distinction, activity recognition) are tests for identification (multiple-choice): whether the shown object or phenomenon to objects or phenomena of this type; tests for the distinction: selecting one solution from the list of possible solutions; tests-lookup: insert the missing word, the chemical formula in the proposed text. Tasks of this type meet the requirements of the basic level of training of graduates of secondary (full) school of chemistry (their offer to perform in the first part of BSE and USE). Comparing the functional responses of students from the reference, the conclusion about the quality of the completed assignments;
- the second level (algorithmic or reproductive activity) represents constructive tests (with a brief free answer, their offer to perform in the first part of BSE and USE). Students are offered to

perform the procedure (calculation) known formula, algorithm. Tasks of this type correspond to the compulsory minimum content of educational programs of high level for the general school;

- the tasks of the third, creative level (productive heuristic activity) are non-standard tasks requiring the application of knowledge to new situations, i.e. transfer their creative skills. These tasks correspond by their content to the most complicated tasks of the traditional written tests in the course of general, inorganic and organic chemistry of the secondary general schools.

In accordance with the principle of minimizing the content we study the minimal number of typical objects considered in different aspects, different phenomena. We identify three methodological approaches to the implementation of the strategy of updating the content of chemical education:

- wide use of digital educational resources in learning (video lectures, video tutorials, computer-aided chemical experiment);
- application of the new task technologies of design and project nature, the performance of which includes both qualitative and quantitative experiment);
- practical exercises in the form of mini-research or project.

## 6. Discussion

Here are some examples of lessons in the 8<sup>th</sup> grade of basic, advanced, and specialized levels of training.

Lesson 1. Practical lesson in the 8<sup>th</sup> grade on the topic "Preparation of salt solutions with a particular mass fraction of a solute and a given molar concentration in the solution".

We specify the purpose of work for each student, for example: 1) prepare 150 g of 2% solution of sodium chloride; 2) prepare 50 ml of a solution of potassium chloride with a molar concentration of 0.2 mol/l.

After a conversation with the students on safety and the order of the compliance with the work the students are offered cards with algorithmic regulations. Students perform actions according to the algorithm.

The algorithm is cooking salt solution with a certain mass fraction of the solute in the solution is as follows:

Calculate the mass of salt and water by the formula:

$$m(\text{salt}) = w(\text{salt}) \cdot m(\text{solute});$$

$$m(\text{H}_2\text{O}) = m(\text{solution}) - m(\text{salt}).$$

2. Weigh a portion of salt.
3. Place a portion of salt into the flask.
4. Measure with a graduated cylinder the required amount of distilled portion of water.
5. Add the water portion in the flask with salt.
6. Stir the contents of the flask with a glass rod until complete dissolution of the salt.

The algorithm for preparation of a solution with a given molar concentration of salt is the following:

1. Calculate the mass of salt according to the formula:

$m(\text{salt}) = M(\text{salt}) \cdot C(\text{salt}) \cdot V(\text{solute})$ , where  $m$  is the mass of salt in grams;  $M$  is the molar mass of salt in g/mol;  $C$  – molar concentration of salt in the solution in mol/l;  $V$  – volume of solution in liters.

2. Weigh a portion of salt with the allowable deviation of the weight of 0.01 g.

3. Place a portion of salt in volumetric flask.

4. Pour distilled water in a volumetric flask, bringing the solution volume to the mark.

When you perform calculations using formulas, you should pay attention of students that the formula also represents an algorithm, if you strictly specify a sequence of actions, choosing the most rational of them. So, the formula is  $m = M \cdot C \cdot V$  is obtained from the relationship linking the molar concentration of salt in the solution and molar mass of salt:

$$\begin{array}{l} C = \frac{v}{V} \\ C = \frac{m}{M \cdot V} \end{array} \quad \begin{array}{l} \left. \begin{array}{l} \rightarrow \\ \leftarrow \end{array} \right\} \begin{array}{l} M = \frac{m}{v} \rightarrow v = \frac{m}{M} \\ m = M \cdot C \cdot V \end{array} \end{array}$$

Independent work of students on the implementation of the quantitative experiment is the main part of the lesson. The final part of the lesson is devoted to the presentation of results of work in notebooks and the correlation of these results with the objectives.

Lesson 2. Study: Practical lessons in class 9 with advanced study of chemistry on the theme "building a solubility curve of a substance from experimental data" (Akhmetov, 1988) takes about two hours.

The purpose of the study:

- determine the solubility of given salt at various temperatures (students work in groups of 3-4 students, each target group is specified, for example, to determine the solubility of potassium chloride at the following temperatures: 20, 40, 60, 80°C);
- build a curve of solubility of salts depending on temperature;
- interpret the results of a study comparing the curve of solubility of this salt from the solubility curves obtained for the other salts other research groups as well as with the solubility curve of this salt is given in the textbook;
- articulate the pattern, reflecting the dependence of solubility of solids versus temperature.

In discussing the progress of the study, it is important to focus on whether it was always true to this pattern, are there any examples that did not support the findings. As homework students could be asked to analyze relevant literature and to find examples of mysterious natural phenomena related to the process of solubility, for example, why some of the pore solutions, which are small pores in the bowels of the Earth not freeze to -70°C.

## 7. Conclusion

The learning process should be constructed in accordance with the "natural way of knowledge." The use of "real objects or at least their images" is an important condition of its success. It is necessary to focus on mastering the content related to personal observations of students, with the results of their perception, classification, and understanding and modeling allowing to build models and "look at" objects

in micro-and nanoworld. With this purpose, the organization of virtual tours in the nanoworld, the use of different multimedia components of the learning process helps facilitate learning. The theoretical content should be taught in the format of video lectures with extensive use of traditional forms and training methods, such as qualitative objectives and the new ones (virtual experiment, a research and design activities, computer simulation, etc.).

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