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- 13.00.00 Pedagogika fanlari
- 13.00.01 Pedagogika nazariyasi. Pedagogik ta'limotlar tarixi
- 13.00.02 Ta'lim va tarbiya nazariyasi va metodikasi (sohalar bo'yicha)
- 13.00.03 Maxsus pedagogika
- 13.00.04 Jismoniy tarbiya va sport mashg'ulotlari nazariyasi va metodikasi
- 13.00.05 Kasb-hunar ta'limi nazariyasi va metodikasi
- 13.00.06 Elektron ta'lim nazariyasi va metodikasi (ta'lim sohaları va bosqichlari bo'yicha)
- 13.00.07 Ta'limda menejment
- 13.00.08 Maktabgacha ta'lim va tarbiya nazariyasi va metodikasi
- 13.00.09 Ijtimoiy pedagogika
- 07.00.00 Tarix fanlari
- 19.00.00 Psixologiya fanlari
- 01.00.00 Fizika-matematika fanlari
- 02.00.00 Kimyo fanlari
- 03.00.00 Biologiya fanlari
- 09.00.00 Falsafa fanlari
- 10.00.00 Filologiya fanlari
- 11.00.00 Geografiya fanlari

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SYSTEMATIC APPROACH TO THE ISSUES OF EDUCATIONAL CALCULATION IN GENERAL SECONDARY SCHOOLS

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Abstract: This article examines a systematic approach to solving educational and computational problems in general secondary schools. It analyzes the general structure of such problems and differentiates their features into various types. The study presents theoretical modeling of activity programs for solving computational problems that are sufficient for the identified types, as well as the development of a systematic guiding basis for their implementation. In addition, experimental classes were conducted with a focus on organizing students' guiding activity within a systematic framework.

Key words: educational calculation problem, problem solving, systemic thinking, guiding basis of activity.

Annotatsiya: Mazkur maqolada umumta'lim maktablarida o'quv-hisoblash masalalarini yechishga tizimli yondashuv masalalari yoritilgan. Unda masalaning umumiy tuzilmasi ochib berilib, uning belgilari turli turlarga ajratilgan. Shuningdek, aniqlangan masala turlari uchun yetarli bo'lgan faoliyat dasturlarini nazariy modellashirish, ularni amalga oshirishga xizmat qiluvchi tizimli yo'naltiruvchi asosni shakllantirish hamda tizimli faoliyatni tashkil etish asoslari bayon etilgan. Tadqiqot doirasida o'quvchilarning yo'naltiruvchi faoliyatini tashkil etishga qaratilgan eksperimental mashg'ulotlar o'tkazilgan.

Kalit so'zlar: o'quv-hisoblash masalasi, masala yechish, tizimli tafakkur, faoliyatning yo'naltiruvchi asosi.

Аннотация: В статье рассматриваются вопросы системного подхода к решению учебно-вычислительных задач в общеобразовательных школах. Раскрывается общая структура задачи и осуществляется дифференциация её признаков по различным типам. Представлено теоретическое моделирование программ деятельности по решению вычислительных задач, достаточных для выявленных типов, а также формирование системной ориентировочной основы деятельности и условий её реализации. В рамках исследования проведены экспериментальные занятия, направленные на организацию ориентировочной деятельности учащихся.

Ключевые слова: учебно-вычислительная задача, решение задач, системное мышление, ориентировочная основа деятельности.

INTRODUCTION

One of the peculiarities of the 21st century is explained by the unprecedented acceleration of scientific and technological progress and, as a result, changes in the lifestyle and main activities of even a single generation. Specialized knowledge in certain fields often becomes obsolete after students graduate from an educational institution.

A person should constantly replenish their knowledge and skills throughout life and remain ready to learn. This trend will undoubtedly continue in the future. In our country, this process is taking place alongside changes in the social system. It has become necessary to reorganize entire sectors such as industry and agriculture and, as a result, to redirect and retrain large segments of the population.

In the context of a new, rapidly changing, and increasingly complex world, the formation of not only qualified executive specialists but also managers and entrepreneurs who are capable of acting responsibly, proactively, and creatively, as well as deeply perceiving and analyzing ongoing processes, identifying existing problems, and finding optimal solutions, is of paramount importance. Therefore, at all stages of the modern education system, particularly at the level of basic secondary education, one of the key objectives is not only the assimilation of a certain volume of knowledge by students but also the formation of theoretical thinking. This enables learners to independently acquire knowledge, work with diverse information, create a holistic picture of the current situation, and perceive the analyzed object in all its interconnections and relationships.

At the same time, effective teaching of chemistry problem-solving is impossible without a system that covers the entire course or its individual thematic blocks. Learning to solve problems of each type should be integrated with mastering the theoretical content of chemistry. Under conditions of limited instructional time, chemistry teachers especially require a well-designed system of tasks that supports the development of students' cognitive abilities. Such a system should not include an excessive number of problems of the same type; instead, tasks should be selected in a way that allows students to find solutions not only to typical problems but also to those requiring creative thinking. Problems may be used at any stage of the lesson as well as in extracurricular activities.

Taking into account the data obtained during a cycle of pedagogical research, this study considers the use of computer technologies to increase the effectiveness of chemistry teaching in general education schools. It also addresses the development of a methodology for using the electronic publication "Chemistry: Self-Education for Schoolchildren (using an interactive method in teaching the solution of problems related to the main classes of compounds of inorganic substances using the method of proportions)" (in the Karakalpak language) in chemistry instruction, as well as the formation of students' theoretical thinking with a systematic orientation.

Thus, within the framework of a cycle of pedagogical research on the formation of systemic thinking in students through teaching the solution of computational problems related to the main classes of compounds of inorganic substances, and through the application of computer-based methodologies to enhance the effectiveness of chemistry education in schools, a comprehensive system of pedagogical research was implemented. The development of knowledge through a systematic study of the subject also determines the system of educational problems as a means of organizing the assimilation of educational material. In previous studies aimed at the formation of systemic thinking [41; 12–18; 64; 54–55], systems of educational problems were developed to master methods of systematic analysis of objects. In this research, the process of solving computational problems in education was selected as the subject of study not on the basis of pragmatic considerations but on theoretical grounds, particularly the use of algorithms in problem-solving. This approach requires a specific orientation toward the object of study, theoretical means for organizing its analysis, and the ability to direct the analytical process toward an effective solution.

Conducting our research within the framework of pedagogical studies on the formation of systemic thinking in students through teaching the solution of computational problems related to the main classes of compounds of inorganic substances, and through the application of computer-based methodologies to enhance the effectiveness of chemistry instruction, we approached the issue of educational and computational problems in chemistry from the perspective of organizing an integrated educational and methodological system.

The concept of a problem may be regarded as one that has acquired the status of a category in contemporary scientific discourse. It functions in all spheres of socio-historical practice. The objective reality reflected in this concept is human activity aimed at transforming objects and converting them into objects that satisfy human needs. Depending on the nature of the need to be addressed and the subject content of the activity, various types of problems are distinguished, including practical, cognitive, aesthetic, moral, communicative, and others. The relationship between the initial properties of an object and the final properties of its transformed state, which constitutes the object of need, represents the most general form of a problem. Without activity, it is impossible to set and achieve a goal, as the goal and the result are the main characteristics of activity. In this context, a problem expresses the relationship between the subject and the object through the activity of the subject and its internal relations, namely, the connection between the goal and the result through an intermediate link.

LITERATURE REVIEW

Different researchers describe this link in various ways: "conditions for achieving the goal" (A. N. Leontiev), "means of achieving the goal" (N. N. Trubnikov), and "methods of activity" (V. V. Davydov). The central aspect of problem-solving lies in the analysis of the intermediate link, that is, in revealing the conditions of the problem as a system of internal relations connecting the goal and the result of the activity [27–576]. The hidden predetermination of these relations gives the situation the character of a problem that the subject must resolve through activity. Thus, the subject's activity acts as an intermediary link between the goal and the result.

Conscious problem-solving presupposes an analysis of the activity itself and its internal relationships as conditions for transforming the goal into the result. In this regard, the following elements of activity are distinguished: the goal of activity, the subject of activity, its means, the program of activity, and the processes carried out within it. All these elements are interconnected by the "principle of conformity," which serves as a condition for achieving the result as a realized goal. The subjective reflection of an objective problem functions as a regulatory link in activity and forms its guiding basis. The characteristics of the guiding basis formed by the subject determine the choice of the method of solution, the direction of problem-solving, and its final outcome.



Accordingly, a problem solved mentally by the subject reflects the unity of the objective and the subjective, encompassing both the reality of the activity performed to achieve the goal and the structure of the problem as an internal regulator of that activity. Difficulties encountered by students in solving educational problems are associated with the formation of this guiding basis. The study of problem-solving therefore includes two interconnected aspects:

- 1) the formation of guiding research activity (FIA), which shapes the subjective image of the objective problem and the activity required to solve it; and
- 2) the application of this image in the actual process of problem-solving.

The first aspect is rarely reflected in teaching methods, while the second is typically implemented through ready-made “recipes” for solving specific types of problems or through general instructions on how to solve a problem, such as carefully reading the conditions, understanding them, recording them, developing a solution plan, and carrying it out. Such instructions allow for the creation of a meaningful representation of the problem and, to some extent, enable the identification of its type and the selection of an appropriate method. However, they do not sufficiently support the recognition of the general structural framework of problems and their variants, nor do they fully facilitate independent problem-solving.

In pedagogical research, insufficient attention is often paid to the subjective dimension of the problem, namely, the construction of its guiding basis. As a result, the object of analysis is reduced to formal-logical relations, excluding the subject and their activity as essential conditions for solving the problem. In addressing this issue, significant contributions have been made by the theory of the gradual formation of mental actions (P. Ya. Galperin) and the theory of educational activity (V. V. Davydov, D. B. Elkonin), as well as by psychological and pedagogical studies focused on the mechanisms of forming a guiding basis of activity and the possibility of its development in a generalized form.

The essence of educational problems lies in teaching students to reveal the objective mediating link within a problem by:

- studying the conditions required to achieve the desired result and constructing a mental image of these conditions;
- moving toward the desired result and independently setting a program of action.

For the formation of generalized skills, the selection and reflection of a general theoretical method for analyzing a problem on the basis of a guiding framework is of particular importance [10–64].

In our work, which focuses on the use of computer technologies to enhance the effectiveness of chemistry teaching in general education schools, the development of a methodology for applying the electronic publication “Chemistry: Self-Education” (EN) in the Karakalpak language for schoolchildren—using interactive methods to teach the solution of problems related to the main classes of inorganic compounds through proportional methods—and the formation of students’ theoretical thinking with a systematic orientation, we adhere to the same principles. Activity aimed at solving educational calculation problems involves determining the content, structure, and tools of activity required to address systematically oriented problems within a given topic. In solving computational problems related to the main classes of inorganic substances in chemistry, the development of students’ thinking processes, the formation of sequential action skills, and the ability to work with problem conditions lead to the adoption of an algorithm-based approach in teaching problem-solving.

RESEARCH METHODOLOGY

The research methodology of this scientific study was based on a systematic approach to data collection and analysis. Primary data were obtained through classroom observations of the process of solving educational calculation problems in chemistry in general secondary schools, as well as through the analysis of teaching activities conducted in both traditional and experimental classes. In addition, pedagogical experiments were carried out to identify differences in students’ learning outcomes under varying instructional conditions. Diagnostic tasks and control assessments were used to collect quantitative and qualitative data on students’ knowledge, skills, and problem-solving abilities. The collected data were analyzed using comparative and analytical methods, which made it possible to evaluate the effectiveness of system-oriented and algorithm-based teaching approaches. The analysis focused on identifying changes in students’ logical reasoning, ability to analyze problem conditions, and independence in solving computational problems, leading to the formulation of generalized conclusions.

ANALYSIS AND RESULTS

The use of algorithms in problem-solving develops the ability to reason logically, analyze relationships between quantities, identify key concepts under study, determine optimal solution strategies, and sequentially divide actions into “steps” that lead to obtaining the desired result. The structure of a problem, identified as an invariant element, should manifest itself as a variant in each specific problem. Identifying the main variants of this invariant makes it possible to determine the type of problem and to select an adequate program for its solution. Such an approach to problem analysis, which reveals its systemic and structural organization, enables a higher level of generalization.

The following methods were used to address the research problem:

1. A systematic analysis of educational calculation problems conducted by the author in order to identify the general structure of a problem and differentiate its features into various types, based on the content of the main classes of inorganic compounds within the school chemistry curriculum.
2. Theoretical modeling of activity programs for solving computational problems that are sufficient for the identified types; their implementation contributes to the construction of a systematic guiding basis for problem-solving.
3. Experimental classes involving the organization of students' orientational activity aimed at developing a systematic framework of orientational activity (FSA) and selecting appropriate methods for solving various types of problems related to the main classes of inorganic substances in chemistry.
4. A comparative method involving the comparison of educational outcomes in traditional and experimental groups, followed by their analysis, evaluation of effectiveness, and formulation of conclusions.

Within the framework of the study, the following tasks were set:

- to examine the possibilities and conditions for the formation of theoretical thinking in students with a systematic orientation in teaching the solution of computational problems related to the main classes of inorganic compounds in chemistry, through the application of computer-based methodologies aimed at increasing the effectiveness of chemistry education in schools, as well as to identify types of chemical calculation problems based on their structural features and to develop normative methods for their solution;
- to theoretically develop a program for forming system-oriented algorithmic foundations of students' ability to solve problems related to the main classes of inorganic compounds in chemistry;
- to design an experimental teaching methodology and prepare all necessary didactic materials;
- to form experimental and control groups and verify students' initial skills in solving computational problems related to the main classes of inorganic compounds in chemistry;
- to conduct experimental classes and determine parameters for assessing learning outcomes;
- to carry out a comparative analysis of learning outcomes in the experimental and control groups.

CONCLUSION AND RECOMMENDATIONS

Thus, the study confirms the particular importance of selecting and consistently applying a general theoretical method of problem analysis based on a guiding framework for the formation of generalized skills in students. A systematic approach to solving educational calculation problems enables learners to develop theoretical thinking, consciously organize their actions, and understand the internal structure of problems rather than rely on mechanical solution patterns. The results demonstrate that the use of algorithm-based and system-oriented methods contributes to improved logical reasoning, more effective problem classification, and increased independence in learning activities.

Based on the findings, it is recommended to integrate systematically structured calculation problems into the chemistry curriculum at the level of general secondary education. Special attention should be given to the formation of students' orientational activity and the use of computer technologies as supportive tools in teaching problem-solving. Furthermore, teacher training programs should emphasize the development of methodological competence in applying system-based and algorithmic approaches to enhance the overall effectiveness of chemistry education.

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- 13.00.00 Pedagogika fanlari
 - 13.00.01 Pedagogika nazariyasi. Pedagogik ta'limotlar tarixi
 - 13.00.02 Ta'lim va tarbiya nazariyasi va metodikasi (sohalar bo'yicha)
 - 13.00.03 Maxsus pedagogika
 - 13.00.04 Jismoniy tarbiya va sport mashg'ulotlari nazariyasi va metodikasi
 - 13.00.05 Kasb-hunar ta'limi nazariyasi va metodikasi
 - 13.00.06 Elektron ta'lim nazariyasi va metodikasi (ta'lim sohaları va bosqichlari bo'yicha)
 - 13.00.07 Ta'limda menejment
 - 13.00.08 Maktabgacha ta'lim va tarbiya nazariyasi va metodikasi
 - 13.00.09 Ijtimoiy pedagogika
 - 07.00.00 Tarix fanlari
 - 19.00.00 Psixologiya fanlari
 - 01.00.00 Fizika-matematika fanlari
 - 02.00.00 Kimyo fanlari
 - 03.00.00 Biologiya fanlari
 - 09.00.00 Falsafa fanlari
 - 10.00.00 Filologiya fanlari
 - 11.00.00 Geografiya fanlari



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