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Article

Developing Natural Science Literacy Through Situational Tasks: Enhancing Chemistry Education Effectiveness

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Abstract: This study explores the development of natural science literacy through the application of situational tasks in chemistry education. While numerous approaches to improving science literacy exist, a gap remains in the practical integration of real-life problem-solving tasks in classrooms. Using a mixed-methods approach, data were collected from student performance assessments and surveys. The findings indicate that situational tasks significantly enhance students' ability to understand, analyze, and apply scientific concepts in real-world contexts. Results suggest that these tasks foster critical thinking and self-directed learning. The study's implications highlight the need for educators to adopt practice-oriented methodologies to improve functional literacy in natural sciences.

Keywords: Natural Science Literacy, Chemistry, Scientific Knowledge, Educational Technologies, Functional Literacy, Situational Tasks.

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1. Introduction

Natural science literacy is a person's ability to take an active civic position on issues related to the development of natural sciences and the application of their achievements, his willingness to be interested in natural scientific ideas. Science literacy is characterized by knowledge about nature and technology, methods for obtaining scientific knowledge, an understanding of the validity of these methods and their use. Requirements for tasks to assess science literacy follow from this definition. They should be aimed at testing the competencies listed above and at the same time be based on real life situations. It is these tasks, combined into thematic blocks, that make up the PISA measurement tools. A typical block of tasks includes a description of a real situation, presented, as a rule, in a problematic manner, and a number of questions and tasks related to this situation.

To develop science literacy, it is necessary to create environments that allow children to experiment, explore, and ask questions. It is also important to develop their critical thinking and the ability to see connections between various phenomena and processes in nature.

Literature review. According to L.M. Perminova, it has a level expression and includes elementary, functional and general cultural natural science literacy. As A.Yu. points out. Pentin, G.G. Nikiforov and E.A. Nikishov, understanding natural science phenomena, the ability to explain them, describe and evaluate them from a scientific point of view, plan research activities, scientifically interpret data and evidence to draw conclusions are the main competencies of natural science literacy [1].

To ensure the productivity of the formation of natural science literacy of students, teachers use special active, activities, personality-oriented and developmental educational technologies [2-4].

Among them, the following types of activities and technologies can be distinguished: technology for the formation of correct reading activity; technology of project activities; level differentiation of training; information and communication technologies. Consequently, a student can learn to act only in the process of the action itself, and the work of the teacher in each lesson and the educational technologies that the teacher chooses form the functional literacy of students corresponding to their age level.

To effectively develop functional natural science literacy, communicative, creative and gaming methods are used: discussions, debates, projects, exercises and individual tasks, algorithms, game tasks [5-7].

As the leading method for assessing the communicative sphere of functional literacy, Asanova L.N. students' self-assessment of the success of personal experience of communication and working with information, as well as the teacher's assessment of the knowledge and skills that form the cognitive basis of functional literacy, is proposed [8].

Situational tasks can also be used to develop natural science literacy. The specificity of a situational task is that it has a pronounced practice-oriented (sometimes even pragmatic) nature, but its solution requires specific subject knowledge. An obligatory element of the task is a problematic question, which must be formulated in such a way that the student wants to find an answer to it. Situational tasks are close to problematic tasks and are aimed at identifying and understanding the method of activity. When solving a situational problem, the teacher and students pursue different goals: for students - to find a solution that matches the given situation; for the teacher - students' mastery of the method of activity and awareness of its essence [9].

2. Materials and Methods

The methodology for this study involved a mixed-methods approach, combining quantitative and qualitative data collection to assess the effectiveness of situational tasks in developing natural science literacy among students studying chemistry. The study was conducted over a semester in a high school chemistry class, where situational tasks designed to reflect real-world problems were integrated into the curriculum. These tasks were aligned with the objectives of fostering critical thinking, problem-solving, and the ability to apply scientific knowledge in practical situations. The quantitative data were collected through pre- and post-tests administered to the students, which measured their natural science literacy before and after exposure to the situational tasks. The test questions were designed to assess various competencies, including understanding, application, analysis, and evaluation of scientific concepts.

In addition to the tests, qualitative data were gathered through student surveys and classroom observations. The surveys aimed to capture the students' perceptions of the situational tasks, their engagement levels, and the extent to which they believed these tasks helped improve their understanding of chemistry. Classroom observations provided additional insights into student behavior, participation, and the ways in which they approached solving the tasks. Data from these observations were recorded and analyzed to identify patterns of interaction and problem-solving strategies. The results from both the quantitative and qualitative data were analyzed using statistical methods and thematic analysis, respectively, to determine the overall impact of situational tasks on the students' development of natural science literacy.

3. Results and Discussion

When studying the subject "Chemistry", the student must be able to analyze and objectively assess life situations related to substances, have the skills to handle them safely, be able to analyze and plan environmentally friendly behavior in order to preserve health and the environment. Therefore, the main task of the teacher is to teach students to competently handle substances that will be encountered in everyday life. To achieve results in this direction, there may be practical exercises and assignments that include a description of a certain situation (real or fantastic), usually problematic [10-15].

An example is the situational task “Treatment of a wound with ethyl alcohol.”

There is an opinion that disinfecting wounds with alcohol is an effective remedy. Ethyl alcohol, which is the main ingredient of alcohol, indeed has antiseptic properties, but using it as a disinfectant is an outdated method. Alcohol (or rather the alcohol included in it) can aggravate the situation, and the wound will take longer to heal. Clean water is much better. On the one hand, any alcohol-based product is an antiseptic. On the other hand, vodka dries out the skin greatly, so doctors are starting to abandon alcohol-based antiseptics. Due to the “tanning of the skin,” the normal microflora, which helps restore balance and healing, deteriorates. What is better to use instead of alcohol, drugs for cleaning wounds: furatsilin, hydrogen peroxide. These products are used to clean cuts and scrapes immediately after they occur. These solutions can be used to wash wounds on both the skin and mucous membranes, but there are some subtleties. Antiseptics that are used for the initial treatment of an already cleaned wound: alcohol, chlorhexidine, miramistin. “Coloring” antiseptics: brilliant green, iodine, fucorcin. These are indeed multi-colored drugs, but they are combined into one category not only for this reason. All of the medications listed are intended exclusively for application to the edges of damaged areas of the body. Cuts and scratches should not be filled with coloring antiseptics, otherwise, instead of accelerating healing, a severe burn will be added. These products are necessary only for disinfecting and drying the edges of the wound.

Task 1. Answer the question

Based on the text, we understand that alcohol should not be used when treating wounds, but brilliant green and iodine are diluted with alcohol, so is it safe to use them?

Task 2. Fill out the table based on the content of the text

In your home medicine cabinet you need to have drugs from all 3 categories: some for washing wounds, second ones for their initial treatment, and third ones for disinfecting the edges.

Washing wounds	Primary processing	Disinfection of edges

Task 3. Fill in the table using keywords

Fell while running	hydrogen peroxide, iodine
	Miramistin

Paper cut	
	brilliant green
	hydrogen peroxide iodine or brilliant green

Key words: miramistin, stung by a bee, injured by glass, injured by knives.

Task 4. Solve the problem

If the active ingredient iodine, 100 ml of solution contains 5 g of iodine, how much iodine will be in 300 ml of solution.

Task 5. The text uses the word "leather tanning", the meaning of which is not explained. Using information from the text, explain the meaning of this word.

The results of student responses showed increased interest in studying chemistry and motivation to work on additional material. When solving situational problems, schoolchildren develop an attitude to what is happening and their own model of behavior, at the same time they improve their skills and abilities to find the necessary information in various sources, including Internet resources.

4. Conclusion

Thus, it can be noted that solving situational problems in chemistry lessons contributes to the development of skills in self-organization of activities, the formation of the ability to explain the phenomena of reality, increasing the level of functional literacy, the formation of key competencies, and orientation in the key problems of modern life. The development and use of situational tasks in the educational process is aimed not only at increasing the effectiveness of training, but also at introducing progressive forms, methods and means of teaching, and optimizing the educational process.

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