Competence-oriented tasks as a means of forming natural science literacy

T P Platonova¹ and A P Pakusina²

¹ Department of Chemistry and chemical technology, Amur State University, Blagoveshchensk, Ignatievskoe St., 21, Russia
² Department of Chemistry, Far Eastern State Agrarian University, Blagoveshchensk, Politekhnicheskaya St., 86, Russia

E-mail: pakusina.a@yandex.ru

Abstract. Science literacy is an important component of functional literacy. An effective means of forming functional literacy, that is, the ability to solve standard life tasks in various fields of activity on the basis of applied knowledge, are competence-oriented tasks. Competence-oriented tasks are successfully used in the study of disciplines for students in agricultural and engineering fields. The article provides types and examples of subject, interdisciplinary and practical competence-oriented tasks with chemical and biological content. Competence-oriented tasks differ from traditional ones in that the condition of the task is formulated as a plot, situation or problem, for the solution of which it is necessary to use knowledge that is not explicitly indicated in the text of the task.

1. Natural science literacy as a component of functional literacy

Natural science literacy is defined as the main goal of school science education in most developed countries of the world [1-2] and reflects a person's ability to apply natural science knowledge and skills in real life situations, to take an active life position on issues related to the practical application of the achievements of natural sciences.

Science literacy is an important component of functional literacy. The task of Russian education is to increase the level of natural science literacy of students, which affects the development of the content and methodology of teaching subjects. The need to solve this problem also arises from the decrees of 2018 of the President of the Russian Federation, according to which our country should enter the top ten leading countries in the world in terms of the quality of general education by 2024. To implement the competence-based approach in higher vocational education, competence-based tasks (COT) are effectively used. They are used both in the subjects of the general education and the professional cycle for students studying in agricultural and engineering fields.

Today, the formation of specific abilities of students and students for the analysis and transfer of the acquired knowledge and skills to new situations is urgent, rather than the development of algorithmized content. The formation of these abilities is realized through COT, with the help of which independent, educational, cognitive, research, project activities of students are effectively organized [3]. The relevance of COTs lies in the fact that they are offered in all international studies such as TIMSS, PISA [4-5]. In the development of control and measuring materials used in the state final certification, as well as in the conduct of Russian studies of the quality of education - All-Russian verification works (VPR)
and National studies of the quality of education (NIKO), global trends in assessing educational achievements of students and the results shown by Russian schoolchildren are taken into account in international comparative studies of the quality of education. The main reason for the low rating of Russia in the research of natural science literacy PISA is associated with the insufficient formation of functional literacy among Russian students, namely, with their inability to use subject knowledge and skills in solving problems close to real life situations, with a low level of mastering the skills to find new or alternative ways of solving problems, conducting research or carrying out group projects [6].

It is alarming that these results, in contrast to math and reading literacy, have not shown any progress in the PISA study since 2000 [7].

2. The main types of competence-oriented tasks
COT is defined as an integrative didactic unit of content, technology and monitoring of the quality of student training. The implementation of any competency-oriented task involves solving a certain set of tasks, the typology of which is possible according to various criteria. The typology is based on the skills of working with information, since the group of information skills is metasubject, necessary for solving any problem that is part of various general cultural and professional competencies. The following types of assignments are distinguished as the main ones: subject, interdisciplinary and practical [8].

In the condition of subject COTs, a subject situation is described, the solution of which requires knowledge of concepts, laws, the establishment and use of a wide range of connections of subject content. An example of such a task in a biology lesson [9]: in order to find out a way to regulate population growth, the following experiment was performed. Different numbers of tadpoles were placed in two aquariums of the same volume. In the first aquarium, there were twice as many tadpoles; here they grew slowly. A little water was poured from the first aquarium into the second, without changing the number of tadpoles in it. As a result, their growth and development slowed down. Draw a conclusion from this experience. There is no ready-made answer to the task in any textbook, it can be obtained only on the basis of analysis, understanding of information based on knowledge of the laws, in this case, ecology. Quite popular are tasks when information is offered in tabular or graphical form and based on data analysis it is necessary to answer questions.

The condition of interdisciplinary COT describes a situation in the language of one of the subject areas with explicit or implicit use of the language of another subject area. For the solution, it is necessary to apply knowledge from the relevant areas, it is required to study the condition from the point of view of the selected subject areas, as well as search for missing data, and the solution and answer may depend on the initial data selected by the students. Example of assignment [10]: in the exhibition dedicated to the scientific activity of M.V. Lomonosov, which is presented in the Museum of Anthropology and Ethnography. Peter the Great (Kunstkamera, St. Petersburg), cast-iron bombs for public experiments - intact and torn apart - are exhibited as exhibits. These bombs were filled with water, tightly closed with lids and exposed to frost. What happened to the cast iron bombs in the cold? Why? What property of water was investigated in this way? What are the features of the manifestation of this property in water? In PISA studies, content areas refer to subject knowledge. Subject area "Physical systems" - mainly knowledge of the content of physics and chemistry, "Living systems" - biology, "Sciences of the Earth and the Universe" - geography, geology, astronomy. This division is formal, as in PISA studies these subject areas are interdisciplinary in nature. In the condition of practical COT, a practical situation is described, for the solution of which it is necessary to apply not only knowledge from different subject areas, but also acquired by students in everyday life. In this case, a plot is needed and the data in such a task should not be divorced from the real situation. Example of such a task [2]: You are going to concrete a path at a summer cottage. When is it better to do this - in hot dry weather or in rainy, humid weather? Practical COTs are especially relevant for the natural sciences, since the implementation of the program and the FSES involves a laboratory workshop.

3. Content of competence-oriented tasks
COT content includes:
- A description of a problem situation that immerses the student in the context of the assignment, for example: You caught a cold and your throat hurts. It is necessary to prepare a rinse solution;
- An assignment formulation that accurately indicates the student's activities necessary to complete the assignment: study the text below for 5 minutes. Write the name of the substance you want to prepare the solution for. Calculate the mass fraction of hydrogen peroxide in hydroperite. Write the formula for hydroperite;
- Information necessary for the student to complete the task: rinsing the mouth and throat with hydrogen peroxide solutions helps to cope with infection and get rid of an unpleasant odor. It is especially convenient to use for this purpose hydroperite - a complex compound of hydrogen peroxide with urea of the composition (NH₂)₂CO · H₂O₂.
- The task execution form, which sets the structure for presenting to the students the result of their activities to complete the task;
- Task verification tool - the number of points for each stage of activity and the total number of points. (The name of the substance, the solution of which must be prepared, is written - 2 points; The mass fraction of hydrogen peroxide in hydroperite was calculated and indicated - 3 points; The formula of hydroperite is written - 2 points [11].)

Tasks with an ecological context are relevant. For example, at NIKO in chemistry, a task was proposed: Methane is a colorless and odorless gas. Explain why an odorant is added to it - a substance that gives an odor. Ethanethiol CH₃ - CH₂ - SH is used as such a compound. What inorganic substance is ethanethiol derived from? Humans can smell this substance at a concentration of 1 part in 50 million parts of air. Let's take the volume of the kitchen equal to 25 m². What is the minimum amount of ethanethiol that can be felt in this room?

COT differ from traditional word problems in that a condition is formulated as a plot, situation or problem, for the solution of which it is necessary to use knowledge that is not explicitly indicated in the text of the problem or in the textbook. Information and data in a task can be presented in the form of pictures, diagrams, tables, which will require object recognition. In terms of structure, these tasks are non-standard, that is, they provide for several ways of solving, and these methods may be unknown to students and will need to be designed. Information in the assignment may be redundant, missing or contradictory. The task of the student is to be able to correctly select the data he needs to solve the problem, or, if insufficient, to search for additional information.

In the studies of NIKO, VPR, USE, structuring tasks are proposed, focused on transforming information in structure in order to obtain new information about the object of study, disclosing new connections between the elements of the object. The formulation of a task of this type is most often associated with: adding objects to the scheme; dividing objects into groups on a known (or unknown) qualitative or quantitative basis; building a classification or typology of objects. These tasks traditionally cause difficulties for students, since they require a short answer. The task-opportunity, aimed at determining the correct or incorrect answer, forms critical thinking and the ability to distinguish scientific information from pseudoscientific. Comparison task involves the use of a comparison technique - highlighting similar or different properties of objects. These tasks are more interesting and complex than the challenge-opportunity, where you just need to assess the reliability of the information. For example: The list below contains words related to magnifiers. Write down one word that "falls out" of the general row: microscope, telescope, eyepiece, binoculars. Explain your choice [12]. This task is also interesting in that one student will choose the answer eyepiece as part of the magnifying device, and the other - the telescope as a device for observing the stars. Both the one and the other answer will be correct, provided it is justified. To avoid ambiguous answers, you can suggest another series: lens, magnifier, tube, eyepiece, tripod.

In the task-table, where the combination of hierarchical and linear structures occurs, the requirement to structure information implies: partial or complete filling of the table cells with the indicated graphs; building a table for the given properties and relationships of the objects under consideration. As a rule, such tasks cause difficulties for students, since they require a short answer and check the knowledge of
terms and concepts. The task-model (sign-symbolic, figurative) implies the use of modeling techniques for further obtaining information about the object under study. Information is transformed in model problems using symbols, equations, formulas, and in figurative model problems - using drawings, pictures and diagrams. Students with good mathematical background cope with these tasks more successfully. An analogy task is aimed at obtaining new information about an object on the basis of establishing an analogy of some little-studied object with a well-known object in the form of an assumption. An example of a similar task [13]: In the experiment shown in the figure, the experimenter touches a sharp object to the body of an animal hydra. What property of living systems does this experience illustrate? What type of energy in the body of a hydra should the kinetic energy of a sharp object turn into for the animal to change its shape? Give an example to illustrate a similar property in humans

4. Conclusion

Thus, the competence-oriented tasks correspond to the system-activity paradigm of education at school and the competence-based one at the university, which is laid down in the requirements of the Federal State Educational Standard. Natural sciences should be taught not as a set of facts intended for memorization, but as a tool for understanding the world. It is COT that make it possible to solve this problem, contributing to the development of universal educational actions, thinking, research, communicative competencies in students, and also prepare them for successful participation in domestic and international assessment procedures. Competence-oriented tasks make it possible to form functional literacy, that is, to be able to competently, skillfully function in all spheres of human activity.

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