

Article

# Development Of The Methodology Of Natural Science Teachers For Working With Tasks Of The PISA International Student Assessment Program

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**Abstract:** This article aims to improve the methodologies used by natural science teachers in addressing tasks from the PISA international student assessment program, focusing on fostering scientific literacy. By analyzing Uzbekistan's PISA 2022 results, which highlighted low performance in applying scientific knowledge to real-world problems, the study identifies key gaps in teacher preparedness and educational material. A systematic approach is adopted, encompassing the analysis, design, development, implementation, and evaluation of teaching strategies and materials. Emphasis is placed on developing teachers' skills in logical and critical thinking instruction, integrating experiments, and creating differentiated assignments tailored to diverse student needs. The results underscore the necessity of modernizing textbooks, enhancing teacher training, and employing real-world contextual learning to improve student engagement and outcomes. These findings provide actionable recommendations for equipping educators with the tools to prepare students for international assessments and practical life challenges effectively.

**Keywords:** International Assessment Program, Natural Science Literacy, Skill, Cognitive Level, Competence, Experiment, Research, Problem, Context, Critical Thinking, Knowledge, Natural Science, Competence, Standard, Creativity.

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## 1. Introduction

A high-quality education system is the foundation for building a competitive and developed state. In the 21st century, known as the fourth development revolution, humanity is undergoing a number of changes. This means that the 21st century demands the quality of all human actions and results, as well as high-quality human resources. Education refers to all the knowledge that teachers teach students around the world. As a result of learning, students acquire knowledge or a worldview. Despite the fact that the widespread use of techniques and technologies in the educational process has made a significant contribution to improving the effectiveness of learning, they will never replace teachers. The most important factor in education is the teacher, and the quality of education can never be higher than the quality of its teachers. For this reason, a modern teacher must know the weak points in education, conduct teaching in a way that is connected to other subjects and everyday life.

The natural sciences are considered a branch of science, and a good study of them opens the way for scientific research. The study of the natural sciences helps humanity better understand the changes taking place in the environment. Physics and chemistry from natural sciences are one of the subjects taught in high school, and students often have

the concept of a difficult subject due to complex calculations and analysis. Students often think that learning these subjects, which are used in school, is separate from the world in which we live. For this reason, they are unable to connect their acquired knowledge to everyday events. As a result, although they have the ability to remember, they cannot acquire the skills to use the knowledge they have acquired in everyday life.

## 2. Materials and Methods

Research shows that students in our country have very low skills in using acquired knowledge to solve everyday problems. In the PISA 2022 study, students from Uzbekistan scored an average of 355 points in the field of natural science literacy and ranked 80th out of 81 countries. Uzbekistan's low results in the international assessment program indicate that most of our students lack the ability to apply and analyze scientific knowledge when solving problems. A current concern for many is how we can motivate our students to improve their performance. To enhance these results, we first need to prepare our teachers for this program. For this purpose, natural science teachers graduating from higher education institutions must have a good understanding of natural science literacy skills, fully comprehend the essence of science, and find the simplest and easiest ways to impart knowledge to students. Natural science literacy is perceived as a core competence and is defined as an interactive ability to master information resources and technologies, so that a person can interact with the external world and move towards its wider use. In order to improve students' scientific literacy, it is important to improve the content of educational materials alongside the training of teachers. Reviewing and improving educational materials and introducing innovations into them is a complex process that takes place in several stages. This research includes the stages of analysis, design, development, implementation, and verification. During the analysis stage, existing educational materials are analyzed, their relevance to the current process of globalization is analyzed, their connection to practice is analyzed, and the students' interests and skills of the 21st century are embodied [7].

Based on the data analyzed during the design process, an enriched and improved project of new educational material is created. Based on this project, newly developed and tested materials will be prepared by experts. At the next stage, they are implemented in practice and used for classroom learning. This stage is also aimed at identifying improvements in student learning outcomes in natural science teaching materials such as PISA. The final stage is the evaluation process, at which the evaluation process is clearly manifested in practice. Research results show that most of the educational materials taught in our schools are limited to providing theoretical information, and there are very few practical assignments that encourage students to think creatively and critically. In addition, new textbooks for students, such as "Interesting Physics," are very outdated, and the tasks in them do not reflect the current processes of globalization. This requires the revision and improvement of textbooks and teaching materials.

## 3. Results

To develop students' scientific literacy, we must first prepare our teachers for this. After all, the quality of education has never been higher than the quality of a teacher. First of all, we need to prepare our teachers for international assessment programs, to improve the skills and qualifications of our natural science teachers in order to improve the natural science literacy of students.

The development of the methodology for teachers of natural sciences to work with the international assessment program PISA covers the following main areas:

1. Analysis of the structure of assignments: PISA assignments are based on real-life situations, so teachers should learn to analyze the structure of these assignments. This

includes the introduction of contextual interpretation of issues and the development of students' logical thinking skills.

2. Teaching students logical and critical thinking: PISA tests assess not only students' knowledge but also their skills in applying it practically. Therefore, teachers need to provide students with exercises aimed at developing analytical and critical thinking. This requires sets of such exercises and additional educational materials for use in the classroom.
3. Scientific research and experiments: Expanding laboratory work in physics, chemistry, and biology lessons, and implementing experiments develop students' practical knowledge. In evaluation systems like PISA, it is important to find an answer based on an experiment, so this direction needs to be focused.
4. Differentiation of assignments: By developing assignments suitable for students of different levels, it is possible to assign assignments corresponding to each student's level of knowledge. This method helps students better understand tasks and successfully complete them. With this, the teacher helps not only "progressive" students, but also students who are "lagging behind" in their learning, that is, they can mobilize the entire class.
5. Global Approach: PISA assignments are based on international standards and prepare students to acquire global knowledge and compete with their peers in other countries. Therefore, teachers should be aware of international scientific achievements and research and include them in lessons.
6. The use of technologies: By incorporating digital technologies and online platforms into the learning process, students' understanding of topics and their ability to learn independently will increase. It is difficult to answer questions that interest all students in one lesson. With the help of technologies, students will be able to independently learn about the topics they are interested in [5].

#### 4. Discussion

Analyzing the structure of PISA assignments is an important step for teachers and the education system. This analysis will help students gain a deeper understanding of the knowledge and skills needed to successfully participate in international assessment studies. The key features of PISA tasks are:

1. Based on real-life context

PISA assignments often reflect real-life situations. For example, tasks related to energy saving, solving social problems, or environmental issues can be given. In addition to knowing facts, learners need to understand how their knowledge can be applied in everyday life.

2. Multi-level questions

PISA assignments often consist of several questions, with the initial stages testing students' understanding of the subject while the subsequent stages broadening or deepening these knowledge. For example, at the first stage, a question may be asked about the fundamental laws of the natural sciences, and then a question about the practical application of these knowledge.

3. Assessment of solution-seeking skills

PISA tests test students' ability to solve problems independently. This requires students to think logically and systematically. Questions typically have multiple solutions and students are evaluated on how to find the correct solution.

4. Questions in different formats

PISA assignments will consist of questions of different formats:

- Multiple choice questions: In this case, the student must choose one of several answers.
- Open-ended questions: The student should express their thoughts in writing.

- Work with Graphs and Diagrams: Physics assignments require students to analyze various graphs, tables, and diagrams.
5. Developing high-level cognitive skills

PISA tests focus not only on memorizing facts, but also on skills in their analysis, synthesis, and application. These questions require students to think at a high level (for example, understanding cause-and-effect relationships, analyzing experimental results).

6. Assessment based on international standards

The evaluation criteria for PISA assignments are based on international standards. This means that it is important for teachers to be objective in evaluating and adhere to the same requirements. This assessment shows how students are in terms of global knowledge and skills.

7. Contextual knowledge and skills

In natural science assignments, students should demonstrate how well they understand scientific knowledge and can apply it to solve real problems. This requires not only theoretical knowledge, but also the development of skills such as logical thinking, observation, and experimental analysis [9].

Traditional assignments, unlike these assignments, are aimed at assessing students' memory abilities. The following example highlights traditional assignments and natural science literacy questions and their differences.

Traditional question	A natural science literacy question
What is energy exchange?	Where does energy come from for all the vital processes in the human body?
Describe Newton's first law.	Why must a driver wear a seat belt while operating a vehicle?
Describe the neutralization reaction.	Add an indicator to the acetic acid. Pour in ammonia solution until the resulting color disappears. What process occurred?

In addition, together with PISA assignments, various life experiences can be used to increase students' interest. Attracting students' interest and attention is one of the most important factors. Before starting a lesson, the teacher should be able to attract and engage students with a video, an interesting story, or an interesting experience related to the lesson topic. When teaching natural sciences, it is possible to use life experience or interesting tasks and questions, and this must be related to the topic of the lesson. Below are examples of these tasks.

1. The dust does not fall from the surface facing down. What is the reason for this?

This question can be used in teaching the topic "Motion of Molecules" in physics.

2. Why is it easier to prick nuts on hard ground than it is to prick them on soft ground?

From this question comes the question in physics: "Interaction of bodies." "Strength" can be used in teaching.

3. Why do rain drops fall off clothing when it is violently shaken?

This is a question related to the topic of "Inertia" in physics, and if you search for an answer to this question together with students at the beginning of this topic, students will have an understanding of the importance of inertia in our lives.

4. Why are metal staircases (stairs, tram and train stairs) made rough rather than flat?

This question is related to the topic "Strength of friction," in which one can get an idea of the benefits and disadvantages of friction force. By using this question, it is possible to explain the useful aspects of friction force, that is, it is said that without friction force, it will not be possible to move freely, and students can be given the task of finding where friction force causes harm.

5. Which land dries faster after rain - sand or soil? Why?

The phenomenon of capillarity in physics can be explained by analyzing the answer to this question.

6. Why is it that a hurricane often fails to knock down a tree that has dried leaves, but knocks down a leafy tree that is green next to it?

With this question, it is possible to explain how the concept of pressure is related to the surface of a body other than the acting force.

7. Why does a crack sound sound when dry wood burns?

This question can be used to explain the heat expansion of gases in the topic "Pressure in gases."

8. Why are railway sleepers not laid on the ground, but on bulk ballast (sand, gravel, crushed stone)?

By explaining the answer to this question, students gain insight into the influence of pressure on the surface of an object.

9. Why does a person who has dived deeply feel a heaviness in their ears?

This question explains the proportionality of the pressure in liquids to the depth of the fluid.

10. Why does water flow from the samovar first quickly, then slowly to the brogane?

By analyzing the answer to this question, it can be explained that the pressure of water on the bottom (crane) depends on the height of the samovar's water column, and as the height decreases (as the water decreases), the pressure also decreases [13].

Similar questions and assignments can be used to increase students' interest in chemistry, one of the natural sciences, and to explain the importance of the science in everyday life. Below are examples of interesting chemistry assignments.

#### Task 1

##### Mixtures, solutions, and compounds.

Scientists have studied matter and isolated 109 pure substances called elements. Each element consists of exactly the same atoms, so there are 109 types of atoms. Atoms combine to form molecules. The number of combinations is infinite, and they combine to produce many different kinds of matter that make up the universe. Let's try to understand how substances are connected to each other. Is mixing two elements enough to create a new substance? What's the difference between a mixture of sand grains, a salt solution in water, and a chemical compound like rust?

Question: Do substances change in mixtures?

To accomplish this task in practice, we will need a finely ground salt, white flour, teaspoon, water, paper napkin, funnel, mug, and a wide transparent container.

In the first stage of the experiment, equal amounts of salt and flour are poured into one glass and mixed using a spoon. As a result, the substances in the mixture do not differ from each other (Fig. 1). In the second step, water is poured into the glass and stirred again, then waited a while. As a result, the flour drops to the bottom of the cup after a few minutes (Fig. 2).

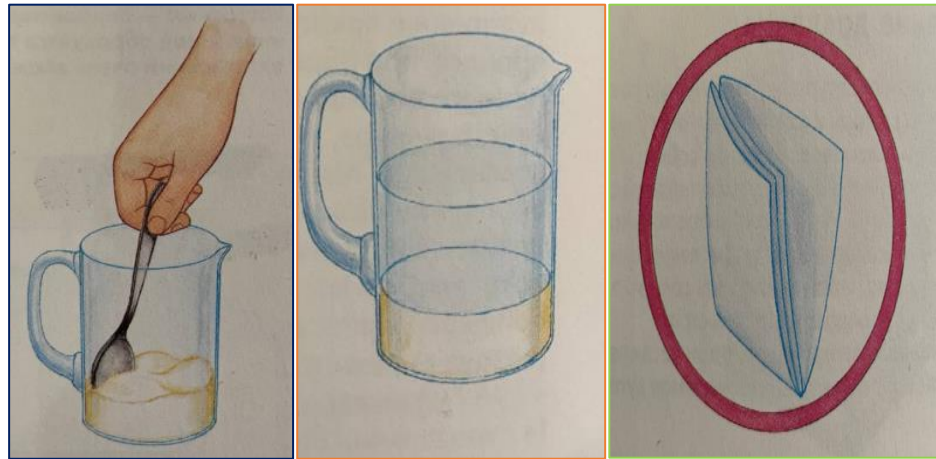


Figure 1

Figure 2

Figure 3

In step 3, a filter is made using a paper napkin, as shown in Figure 3, and it is placed in a funnel.

In step 4, the funnel with the filter is held above the container, and after the aqueous mixture is stirred again, it is poured onto it. After that, the filter is removed from the funnel and dried. The filtered water in the container is placed in a warm place and waited until the water evaporates. As a result, the flour remains in the filter, and after all the water evaporates, a thin layer of salt crystals forms in the container.

This is because flour does not dissolve in water, but it tries to separate from it and sinks to the bottom. This phenomenon is called subsidence. Furthermore, the flour particles are too large to pass through the paper holes, so they are captured by the filter. This method of separating substances is called filtration. Salt dissolves in water and remains in it until the water evaporates under the influence of heat. Then the salt returns to the solid state in the form of crystals. This method of separating components from solution is called crystallization [12].

This simple but interesting experiment can be done by students independently or in class. This experiment can be used to explain the difference between a physical phenomenon and a chemical phenomenon.

Finding interesting tasks like this does not pose a problem for natural science teachers, but it greatly helps to attract students' attention in the lesson.

## 5. Conclusion

The results of the analysis and observations show that PISA assignments encourage students to think logically and creatively compared to traditional assignments, and the use of these assignments in natural science teaching develops in them the ability to think independently and choose the most optimal answer among alternative options, and make decisions based on acquired knowledge. Teachers can prepare students for high results by incorporating these features of PISA assignments into their lessons. These methodological approaches, along with the successful participation of teachers in PISA studies, provide significant assistance in preparing students for independent life.

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