



## DEVELOPING STUDENTS' LEARNING - COGNITIVE COMPETENCIES THROUGH PISA TASKS IN BIOLOGY LESSONS

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### ABSTRACT

*This article investigates the development of students' learning-cognitive competencies through the use of tasks within the framework of the PISA (Programme for International Student Assessment) international assessment program in biology lessons. The necessity of shifting from the acquisition of ready-made knowledge to the formation of functional literacy in modern biological education is scientifically substantiated. During the study, PISA-type contextual tasks were introduced into biology classes of general secondary schools, and their impact on students' critical thinking, data analysis, and conclusion-drawing skills was determined through pedagogical experimental research. The obtained results demonstrated the high effectiveness of PISA tasks in increasing students' cognitive activity.*

**Introduction.** In the era of global economic and technological development, the primary goal of the education system is no longer limited to providing students with fundamental knowledge; rather, it increasingly focuses on developing the ability to apply this knowledge in real-life situations, that is, functional literacy. Uzbekistan's integration into the international educational space and its participation in international assessment programs such as PISA (Programme for International Student Assessment) necessitate a fundamental reform of biological education methodologies.

Biology serves as the foundation of scientific literacy. According to the PISA

assessment framework, scientific literacy encompasses three key competencies: explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically. Traditional biology lessons often emphasize the memorization of factual material, which may hinder the adequate development of students' learning-cognitive competencies. In contrast, PISA-type tasks are problem-oriented and require students to identify and analyze biological principles within real-life contexts presented through texts, graphs, and diagrams.

The purpose of this study is to develop a methodology for the

systematic use of PISA tasks in biology lessons and to evaluate their effectiveness in developing students' learning-cognitive competencies.

**Methods.** The study was conducted during the 2025–2026 academic year in Grade 8A and Grade 8B classes of School No. 37 in Furqat District, Fergana Region, within the subject *Human and Health*. Grade 8A served as the experimental group and included 24 students, while Grade 8B served as the control group and included 30 students.

To process the experimental data, commonly used statistical methods in pedagogical research were applied, including quantitative comparison, percentage growth dynamics, and average performance indices. These methods were selected because they provide a clear representation of student performance and effectively demonstrate differences between the experimental and control groups (Table 1).

*Table 1. Initial Assessment Results in Experimental and Control Groups*

Group	Total Students	High	Medium	Low
Grade 8A (Experimental)	24	4 (16,7%)	10 (41,7%)	10 (41,7%)
Grade 8B (Control)	30	5 (16,7%)	13 (43,3%)	12 (40,0%)

In the experimental group, the topic “*Respiratory System: Structure, Gas Exchange, and Real-Life Situations*” was taught using PISA-style text-based, graphical, problem-based, and open-ended tasks. In the control group, lessons were conducted using traditional teaching methods.

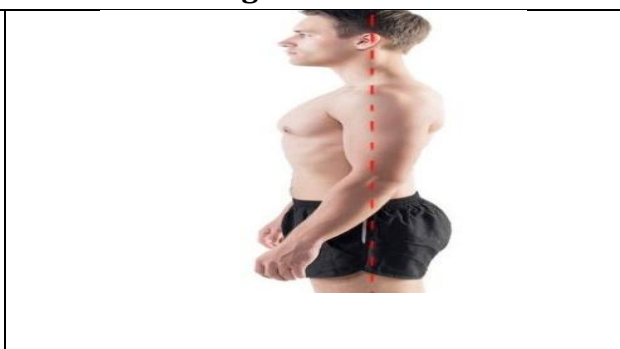
The PISA tasks used in the study covered real-life and social contexts related to the respiratory system. Besides textual information, the tasks

included scientific experiment results presented through texts, graphs, tables, problem situations, and open-ended questions. Students' learning-cognitive competencies were assessed through diagnostic tests and case-based tasks based on the higher levels of Bloom's Taxonomy (analysis, synthesis, and evaluation) at both the beginning and the end of the experiment. Student's *t*-test was employed for statistical analysis.

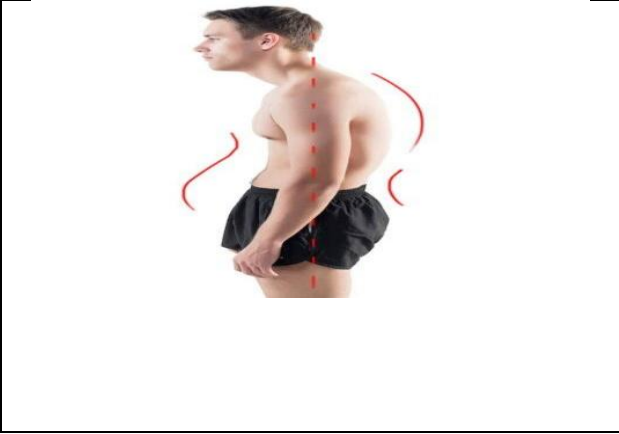
**Context:**

The human spine naturally has physiological curvatures that help maintain ideal balance and absorb shocks during movement. However, due to an improper lifestyle, prolonged sitting, or weakness of certain muscle groups, these curvatures may deviate from their normal alignment. One such

**Figure 1**



condition is known as lordosis (hyperlordosis).  
In lordosis, the forward curvature of the lumbar (lower back) region of the spine becomes significantly exaggerated. As a result, the buttocks protrude backward, while the abdomen extends and hangs forward. The figure below illustrates the difference between normal posture and lordosis.



Doctors and fitness specialists investigated the causes of lordosis and compiled the following table:

<b>Postural Condition</b>	<b>Pelvic Position</b>	<b>Strong/Tight Muscles</b>	<b>Weak/Stretched Muscles</b>
Normal	Neutral (level)	Balanced	Balanced
Lordosis	Anteriorly tilted (tilted forward)	Hip flexor muscles (front thigh muscles) and lower back muscles	Abdominal muscles and gluteal (buttock) muscles

**Task 1.** Based on the text and the table, explain why weakness of the abdominal muscles can lead to the development of lordosis.

A) If the abdominal muscles become weak, they pull the spine backward.

B) Because the abdominal muscles are not strong enough, they cannot properly support the pelvis, causing it to tilt forward.

C) Weak abdominal muscles also weaken the muscles at the front of the thigh.

D) Abdominal muscles affect only the digestive system and are not directly related to posture.

**Task 2.** Sardor, a programmer who spends long hours sitting incorrectly in front of a computer, began experiencing lower back pain. A doctor diagnosed him with lordosis. Using the information in

the table, which muscle groups would you recommend Sardor strengthen (train) and which should he stretch (relax)?

*Your answer:*

Muscles that should be strengthened: \_\_\_\_\_

Muscles that should be stretched (relaxed): \_\_\_\_\_

**Task 3.** Some people consider lordosis to be merely a “postural deformity (a cosmetic issue)” and therefore do not pay serious attention to it. However, from a scientific perspective, what serious medical problems could untreated lordosis cause in the human musculoskeletal system in the future? Explain your opinion using biological principles.

**Assessment Criteria**

**Task 1:** Correct answer: B



Explanation: The table indicates that in lordosis, the pelvis tilts forward and the abdominal muscles become weakened. The abdominal muscles play a supporting role in maintaining the pelvis in its proper position. When these muscles are weak, they cannot adequately stabilize the pelvis, causing it to tilt forward and contributing to the development of lordosis.

**Task 2:** Correct answer:

Muscles that should be strengthened:

Abdominal muscles

Gluteal (buttock) muscles

Muscles that should be stretched (relaxed):

Anterior thigh muscles (hip flexors)

Lower back muscles

Scoring:

Full marks for a completely correct answer.

Half marks if only one part of the answer is correct.

**Task 3:** Expected answer concept: Lordosis is not merely a cosmetic problem. Excessive curvature of the lumbar spine disrupts the normal distribution of mechanical load and pressure on the vertebral column. This may lead to:

Development of intervertebral disc herniation (herniated disc);

Compression of nerve roots, resulting in chronic pain and neurological symptoms;

Altered positioning of the pelvic organs, which may impair the normal functioning of internal organs.

Scoring: Full marks should be awarded if the student correctly explains at least one biological or medical mechanism, such as abnormal mechanical pressure, intervertebral disc damage, or nerve compression, and relates it to the consequences of untreated lordosis.

**Results.** At this stage of the experimental study, the impact of PISA-style tasks on students' learning-cognitive activities in biology lessons was statistically analyzed. The analysis was directly related to the research objectives and hypothesis, aiming to demonstrate through empirical evidence that PISA tasks contribute to the development of students' abilities to understand knowledge, analyze information, apply it in real-life situations, and draw independent conclusions.

Before the experiment, both groups demonstrated nearly identical levels of learning-cognitive competencies. However, after the implementation of lessons integrating PISA tasks, significant positive dynamics were observed in the experimental group. The achievement indicators for three major competency criteria are summarized in Table 2.

*Table 2. Growth Rate by Competencies*

Competency	Experimental Group Growth	Control Group Growth	Difference
Understanding and interpreting biological texts	33,4 %	13,3 %	20,1 %



Competency	Experimental Group Growth	Control Group Growth	Difference
Analyzing graphs, tables, and diagrams	37,5 %	16,7 %	20,8 %
Explaining phenomena scientifically	41,6 %	20,0 %	21,6 %
Drawing evidence-based conclusions	45,9 %	16,6 %	29,3 %

The results indicate that the experimental group outperformed the control group across all competencies. The greatest difference was observed in the competency of drawing evidence-based conclusions. This finding can be explained by the fact that PISA tasks specifically require students to select evidence, compare information, and formulate logical conclusions.

Furthermore, the experimental group demonstrated a 41.6% increase in the competency of explaining phenomena scientifically, which was 21.6% higher than the control group. This suggests that the PISA approach serves as an effective methodological tool for fostering cause-and-effect reasoning in biology education.

**Discussion.** The findings indicate that PISA-type tasks transform students from passive listeners into active investigators during biology lessons. The results are consistent with international pedagogical studies (e.g., Bybee, 2018; Sadler, 2021). As emphasized by these scholars, the use of socio-scientific issues in science education significantly enhances students' motivation.

In our study, students experienced the greatest difficulty in drawing conclusions that were not explicitly

stated in textbook texts but had to be inferred from trends presented in graphs and tables. One of the primary reasons for this challenge is the limited amount of time traditionally devoted to working with graphical representations in biology lessons.

Teaching through PISA tasks helps address this gap. Moreover, these tasks promote interdisciplinary integration (Biology + Chemistry + Geography + Mathematics), thereby contributing to the formation of a holistic scientific worldview among students.

**Conclusion.** Based on the conducted scientific and pedagogical research, the following conclusions were drawn:

The use of tasks from the PISA international assessment program in biology lessons is one of the most effective means of enhancing students' learning-cognitive competencies and functional literacy. The experimental results demonstrated that students who worked with PISA tasks showed, on average, a 21–22% higher level of data analysis and scientific reasoning skills compared to students receiving traditional instruction.

To improve the quality of biological education, it is recommended not only to



integrate PISA-based competency tasks into classroom instruction but also to increase their proportion in current

biology textbooks and examination systems.

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