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# DETERMINING THE EFFECTIVENESS OF TEACHING PHYSICS IN GENERAL SECONDARY SCHOOLS BASED ON THE PISA APPROACH

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**Abstract**
This article analyzes the issues of determining the effectiveness of teaching physics in general secondary schools based on the PISA (Programme for International Student Assessment) approach. The study examines methodological approaches aimed at developing students' abilities to apply theoretical knowledge in practical situations, forming problem-solving competencies, and increasing functional literacy levels. Furthermore, a comparative analysis is conducted between traditional teaching methods and interactive, competency-based approaches rooted in PISA requirements. The research findings highlight the critical importance of tasks based on real-life contexts, analytical thinking, and experimental activities in physics education. The article substantiates that the effectiveness of education can be enhanced by utilizing modern assessment criteria and implementing innovative pedagogical technologies into the teaching process. Consequently, it is determined that lessons organized through the PISA approach significantly increase students' independent thinking, problem-solving skills, and overall interest in the sciences.

**Keywords**: Physics education, PISA approach, functional literacy, competency-based learning, scientific literacy, methodological effectiveness, visual-analytical method, problem-solving skills.

## Introduction

In the current context of globalization, the demands placed on the education system are reaching a qualitatively new level. Modern society requires students not only to acquire theoretical knowledge but also to apply it in various real-life situations, analyze problems, and develop effective solutions. The quality of education is now evaluated not by the sheer volume of knowledge, but by its practical application and functional significance (OECD, 2019)[1]. International assessment programs, particularly PISA (Programme for International Student Assessment), enable the determination of educational outcomes based on new criteria. PISA studies focus on assessing the extent to which students can apply their knowledge in reading, mathematics, and the sciences within real-world contexts, grounded in the concept of "functional literacy" (OECD, 2018)[2]. Furthermore, PISA results are recognized as vital

indicators for determining the effectiveness of educational systems and serve as primary sources for shaping national educational policies (Schleicher, 2020)[3].

Physics holds a unique position within the natural sciences, allowing students to form a scientific worldview, draw conclusions based on experimentation, and understand the laws of nature. Physics education is a fundamental tool for developing students' scientific thinking, facilitating the deep mastery of knowledge through observation, experimentation, and modeling (Redish, 2003)[4]. However, practice shows that in many educational systems, physics instruction places excessive emphasis on theoretical knowledge, leaving students' practical and investigative competencies insufficiently developed (Bybee, 2013)[5]. From this perspective, teaching physics based on the PISA approach is regarded as a pressing scientific issue. The PISA approach involves developing "scientific literacy" in students—the ability to utilize scientific knowledge to solve everyday problems (OECD, 2016)[6]. Additionally, lessons organized through a competency-based approach significantly enhance students' skills in independent thinking, situational analysis, and decision-making (Rychen & Salganik, 2003)[7].

The relevance of this research lies in the potential to increase educational efficiency, develop students' functional literacy, and improve their performance in international assessment programs by implementing the PISA approach in physics education within general secondary schools. Therefore, this article analyzes the current state of physics education and develops scientifically grounded conclusions aimed at determining the effectiveness of teaching based on the PISA approach.

**Literature Review**

The issue of organizing physics education based on modern approaches has been at the center of scientific research in recent years. In particular, studies conducted within the framework of PISA demonstrate the paramount importance of the competency-based approach in science education. PISA studies interpret scientific literacy as an individual's ability to use scientific knowledge, identify questions, and draw evidence-based conclusions (OECD, 2018)[2].

Various methodological approaches for improving physics education have been proposed in the scientific literature. Specifically, it is emphasized that the development of scientific literacy is achieved through the formation of students' competence to solve real-life problems on a scientific basis (Bybee, 2013)[5]. Furthermore, interactive methods, modeling, and experimental activities play a crucial role in deepening conceptual understanding in physics education (Redish, 2003)[4]. Research conducted based on the PISA approach shows that, unlike traditional reproductive teaching methods, competency-oriented education serves to develop high-level cognitive skills in students (Schleicher, 2020)[3]. Moreover, the use of real-context tasks in the educational process increases student motivation and aids in the solid mastery of knowledge (OECD, 2019)[1]. At the same time, scientific sources extensively cover the effectiveness of applying innovative pedagogical technologies in physics education. Modern educational technologies, particularly visualization and simulations, help students comprehend complex physical concepts more easily (Mayer, 2009)[8]. This, in turn, serves to develop students' functional literacy in harmony with PISA requirements.

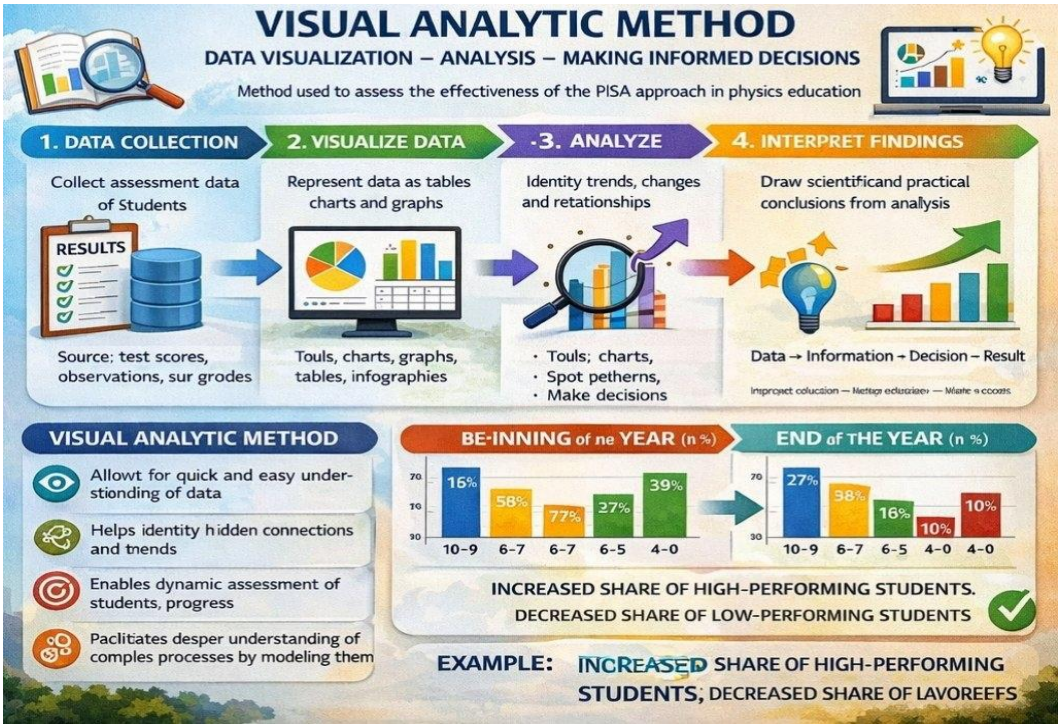
**Methodology**

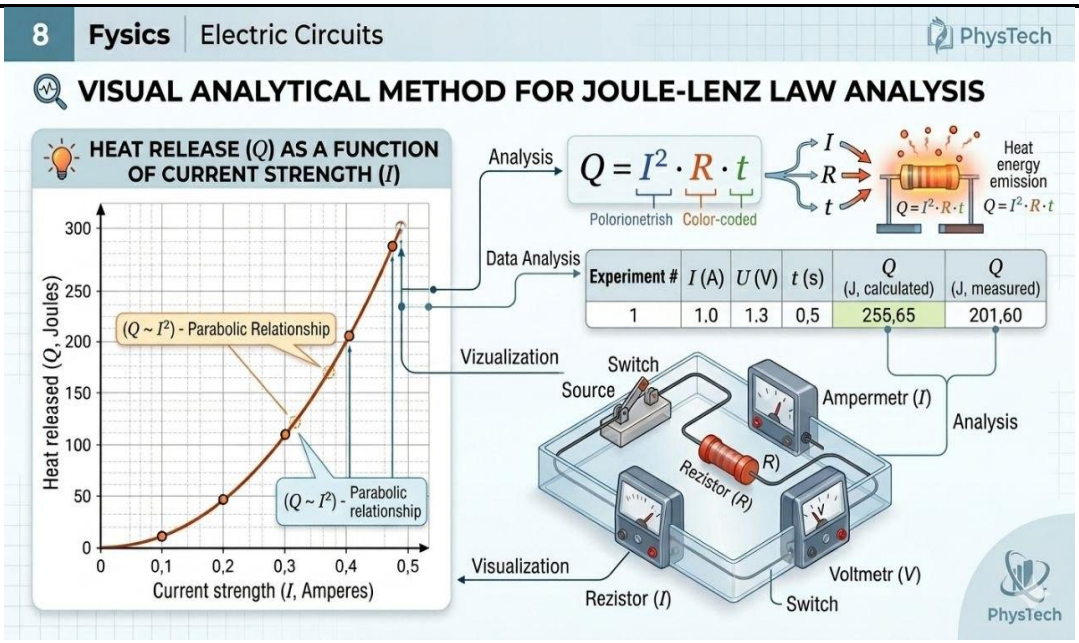
In this study, a complex methodological approach was applied to determine the effectiveness of teaching physics in general secondary schools based on the PISA approach. Theoretical analysis, comparison, generalization, and visual-analytical methods were utilized during the research process. Specifically, the visual-analytical method was selected as one of the primary methods of the study. This method allows for a deep analysis of the learning process and a clear visualization of the results. The visual-analytical method enables the systematic analysis of complex data by transforming it into graphs, diagrams, and visual models (Tufte, 2001)[9].

**The main advantages of this method include the following:**

- It enables rapid and effective perception of data by presenting it in a visual format (Ware, 2013)[10];
- It facilitates the identification of hidden connections and trends during the analysis process (Few, 2009)[11];
- It provides the capability to dynamically assess students' knowledge levels and performance indicators (OECD, 2019)[1];
- It helps in understanding complex physical processes and phenomena more deeply through modeling (Mayer, 2009)[8].

Additionally, the results of the experimental and control groups were compared during the study to evaluate the effectiveness of lessons organized based on the PISA approach. The comparative analysis results indicate that applying a competency-based approach in the educational process significantly increases the quality of students' knowledge and practical skills (OECD, 2018)[2]. As a result, the methodology employed allowed for the achievement of the research objective—namely, determining the effectiveness of the PISA approach in physics education and drawing scientifically grounded conclusions.






**Research Results**

Within the framework of this research, the effectiveness of teaching physics based on the PISA approach was evaluated through experimental trials involving selected 8th-grade student respondents from general secondary schools. The study included students from Schools No. 4 and No. 10 in the Termez district, as well as Schools No. 23 and No. 24 in Termez city. Students' knowledge levels were assessed at the beginning and the end of the academic year, with the results analyzed using the visual-analytical method.

Initial diagnostic results at the beginning of the year revealed a significant differentiation in students' knowledge levels. Specifically, at School No. 4 in the Termez district, only 2 out of 12 students achieved high results (9–10 points), while 4 were at an intermediate level (5–6 points), and 2 were recorded at a low level (0–4 points). A similar trend was observed at School No. 10 in the Termez district, where 9 out of 45 students showed high results, 13 were intermediate, and 6 were at a low level. Although relatively higher results were recorded in the Termez city schools, the proportion of low-performing students remained significant (16 students in School No. 23 and 9 students in School No. 24).

The year-end results clearly demonstrated the positive impact of the PISA approach applied during the experimental process. In School No. 4 of the Termez district, the number of high-performing students increased from 2 to 5, while the number of low-performing students decreased from 2 to 1. In School No. 10, high results rose from 9 to 15, and low results decreased from 6 to 3. The most significant growth was observed in the Termez city schools. Notably, in School No. 23, the number of high-performing students increased from 21 to 33, while low results were reduced from 16 to 10. A positive dynamic was also observed in School No. 24, where high results increased from 11 to 18, and low results decreased from 9 to 6.

**Based on these results, the following scientific conclusions can be drawn:**

✓ The educational process organized based on the PISA approach significantly increased students' high-level performance indicators;

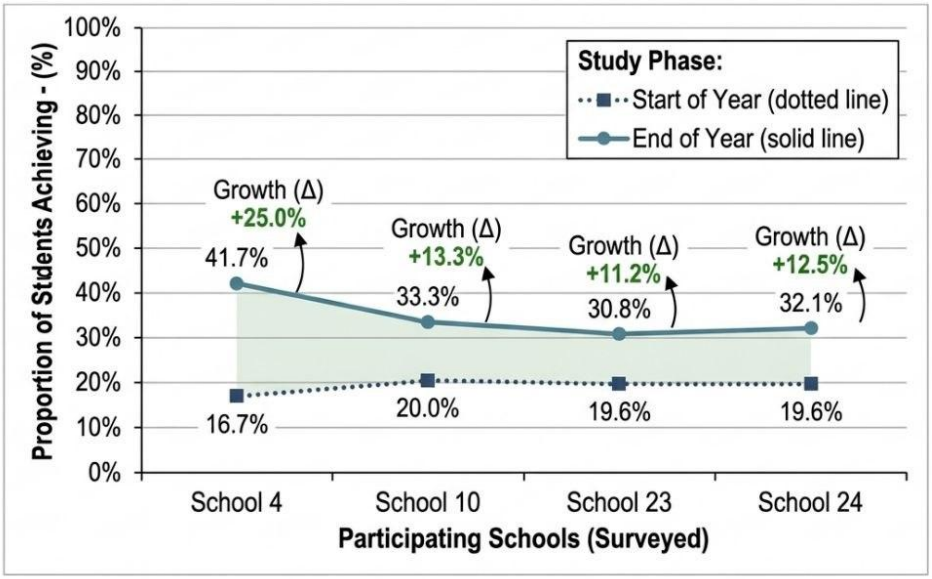
✓ The proportion of intermediate and low-performing students decreased, leading to a reduction in knowledge differentiation;

✓ Students developed skills in problem-solving, analytical thinking, and practical application;

✓ The results obtained through the visual-analytical method enabled an accurate and systematic assessment of students' learning dynamics.

The research findings indicate that physics lessons organized according to the PISA approach significantly develop not only students' theoretical knowledge but also their competencies to apply it in practical situations. This scientifically substantiates the necessity of broadly implementing this approach in the practice of general secondary schools.

Figure 1. Comparison of Academic Excellence (9-10 Point Achievement) over a One-Year Intervention Period.



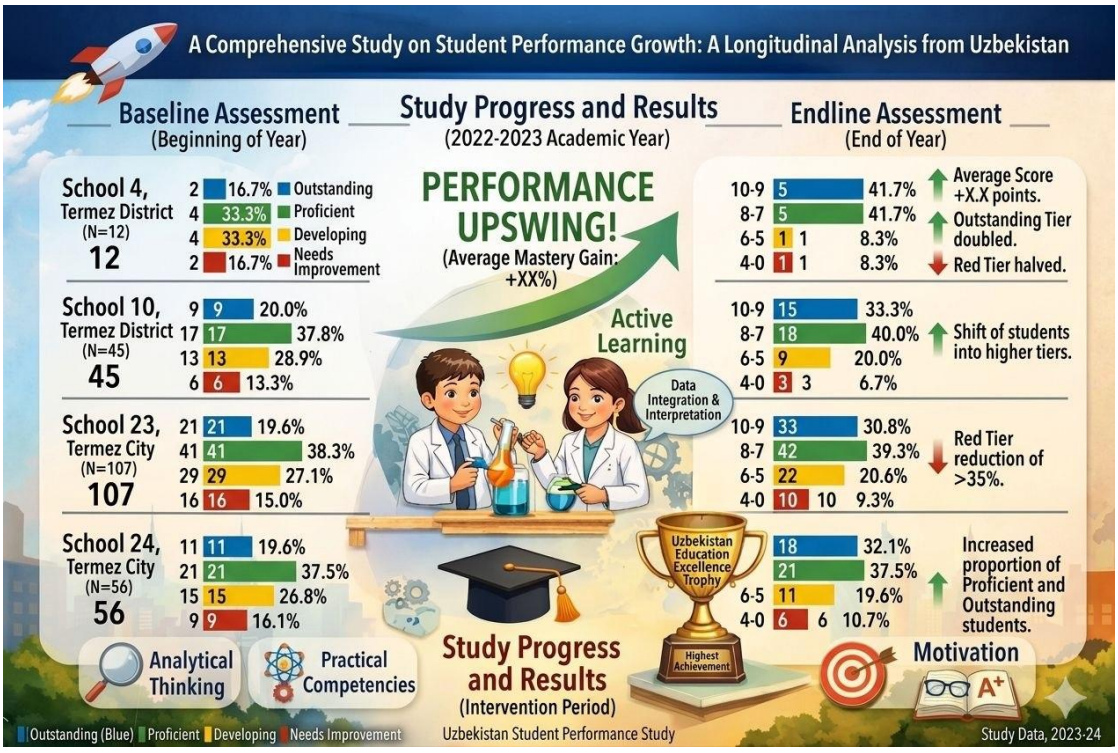

## Discussion

The results of this study indicate that physics lessons organized based on the PISA approach significantly enhance students' knowledge levels and practical skills. While initial diagnostic data revealed a large differentiation in students' knowledge, the year-end results confirmed a narrowed gap between high and low performance indicators, alongside the effective development of intermediate-level students. This demonstrates that receiving an education based on a competency-based approach has served to improve students' abilities in problem-solving, analytical thinking, and the practical application of theoretical knowledge. Comparing these results with the existing scientific literature, they align with the research of Bybee (2013)[5] and Redish (2003)[4], as the PISA approach is fundamentally centered on developing the competence to apply knowledge in practical situations. Furthermore, the results obtained through the visual-analytical method allowed for a clear observation of dynamics and trends

within the learning process, confirming the methodological advantages highlighted by Mayer (2009)[8] and Tufte (2001)[9].

It is also noteworthy that the positive dynamics observed in Termez city schools were significantly higher compared to district schools. This disparity may be attributed to student motivation, the interactivity of the educational environment, and the availability of resources. From this perspective, it is crucial to consider inter-school resource distribution and pedagogical support systems when implementing the PISA approach in practice. The findings also revealed the distinct differences between traditional and competency-oriented approaches. While students acquired more theoretical knowledge through traditional methods, PISA-based lessons significantly increased their scientific literacy, problem-solving capabilities, and practical application skills. This reaffirms the importance of developing functional literacy within the educational process.

In conclusion, the results show that lessons organized via the PISA approach not only raise students' academic performance but also foster independent thinking, analytical approaches, and problem-solving abilities. Therefore, the widespread implementation of this approach in general secondary schools and the innovative application of pedagogical technologies are of paramount importance in increasing educational effectiveness.




## Conclusion

This research demonstrates that teaching physics in general secondary schools based on the PISA approach significantly enhances students' ability to apply theoretical knowledge in practical situations, as well as their capacity to analyze and resolve problem-based scenarios. The findings indicate a reduction in the differentiation of knowledge among intermediate and low-performing students, while simultaneously increasing the number of high-achieving

students. The data obtained through the visual-analytical method enabled a systematic evaluation of changes in students' proficiency levels. Furthermore, the study confirms that interactive and competency-oriented teaching methods develop students' functional and scientific literacy more effectively than traditional approaches. Consequently, it is scientifically proven that the broad implementation of the PISA approach in general secondary schools is of vital importance in fostering independent thinking, the practical application of knowledge, and a heightened interest in the sciences among students.

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