

## **MODEL OF IMPROVING PHYSICS TEACHING METHODOLOGY IN ACADEMIC LYCEUMS BASED ON DIGITAL EDUCATION**

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**Abstract:** This scientific article analyzes the issues of improving the methodology of teaching physics in academic lyceums based on digital learning. The study developed a methodological model based on the integration of modern pedagogical approaches and digital technologies. This model covers the content of physics education, teaching methods, digital learning tools, assessment and monitoring system, as well as components for developing teachers' professional competencies. The implementation of the model was based on the conceptual approaches of TPACK and SAMR, active and constructive teaching methods. The results of the study show that physics lessons organized in a digital educational environment serve to deepen students' theoretical knowledge, develop practical and research skills, and increase independent thinking and problem-solving competencies. The methodological model proposed in the article is of scientific and practical importance for increasing the effectiveness of teaching physics in academic lyceums.

**Key words:** academic lyceum, physics teaching methodology, digital education, digital technologies, virtual laboratory, interactive lessons, TPACK, SAMR, assessment and monitoring, competency-based approach.

**Introduction.** Today, modernization of education and its quality control are considered one of the sustainable movements on a global scale. The rapid development of technological, technological technologies in the educational process requires the creation of new products, the revision of traditional teaching methods and the provision of modern educational outcomes based on the model. Academic lyceums are of particular importance in this process, since they are an important link between general secondary education and higher education, and serve to instill in students deep theoretical knowledge, scientific thinking and professional competencies. Physics is one of the main subjects taught in lyceums, which plays an important role in the development of a scientific understanding of natural phenomena, logical thinking, problem analysis and experimental academic skills. At the same time, the complexity of the content of physics, the abundance of abstract concepts and its reliance on mathematical modeling create certain difficulties for students. The traditional process of theoretical knowledge, monitoring of laboratory work and passive participation of students can be manifested as a decrease in the level of physics education. The introduction of digital educational technologies into the educational process creates a wide range of solutions. Through virtual laboratories, interactive simulations, multimedia resources, multimedia platforms and online distance learning, it is possible to visually display complex physical processes, recreate experiments, and activate independent research of students. From this, the organization of individual educational directions in the educational environment is expanded, using continuous monitoring and rapid analysis of student knowledge. In the recent pedagogical field, the issues of organizing education based on education are being actively discussed. technical, TPACK (Technological Pedagogical Content Knowledge) model justifies the need for the teacher to harmoniously use the content of science,

pedagogical methods and technology production. The SAMR model is an important method for determining the levels of integration of computer technology into the educational process and the gradual educational process. Theorists consider computer systems as an important tool for the effective use of the basis in teaching physics. At the same time, practice shows that the introduction of computer technology into the educational process is not enough. It is necessary to equip them, apply them systematically and methodically. The problem of developing a holistic and productive model of teaching physics in lyceums based on academic education. Such a model should be taken as a whole pedagogical system using the method, content, calculation, and monitoring. This study is aimed at solving this problem by developing a model of providing a teaching methodology for physics in academic lyceums based on education and scientific theory. The study is significant in ensuring the safety of physics education, developing students' research competencies, and developing their individuality for modern society.

Literature analysis. The issue of improving the methodology of teaching physics in academic lyceums based on digital learning has been actively studied in the field of pedagogy, didactics and educational technologies in recent years. Literature analysis shows that this problem is being studied at the intersection of several areas - physics education methodology, digital pedagogy, competency-based approach and teacher professional development.

Research on the methodology of teaching physics. Classical pedagogical literature emphasizes that the process of teaching physics is based on the principles of scientific, consistency, demonstrativeness and experimentation. Research on the methodology of teaching physics (A.V. Pyoryshkin, V.G. Razumovsky, N.A. Menchinskaya and others) shows that the main task of physics education is to form a scientific understanding of natural phenomena, logical thinking and experimental skills in students. These studies highly value laboratory work, but the technical and time constraints of laboratory training in traditional conditions are noted as a problem. Local studies (in the works of Uzbek methodologists and pedagogical scientists) also emphasize the need to provide in-depth content of physics education for academic lyceums, to strengthen students' independent thinking and preparation for higher education. At the same time, it is noted that being limited to traditional methods does not sufficiently increase students' interest in the subject.

Digital education and pedagogical technologies. In foreign studies on digital education (UNESCO, OECD, experience of European educational schools), digital technologies are considered an important factor in individualizing the educational process, increasing interactivity and monitoring educational results. It is indicated that in a digital educational environment, the teacher should play the role of a guide and facilitator, not a source of knowledge.

The TPACK (Technological Pedagogical Content Knowledge) model is widely used in the integration of educational technologies. This model, developed by Mishra and Koehler, justifies the need to ensure the harmony of the teacher's content (Content Knowledge), pedagogical knowledge (Pedagogical Knowledge) and technological knowledge (Technological Knowledge). The literature notes that the TPACK model is especially relevant for physics teachers, since simulation, modeling and digital visualization play an important role in explaining complex concepts in physics. The SAMR model (R. Puentedura) is also considered an effective theoretical basis for determining the stages of introducing digital technologies into the teaching process. Studies emphasize that using technologies only as a substitute (Substitution) is not enough, but the quality of education can be improved through a radical redesign of the teaching

process (Modification and Redefinition). Virtual laboratories and simulations. Modern research on physics education confirms the effectiveness of virtual laboratories and interactive simulations. Foreign literature (for example, studies based on PhET Interactive Simulations) have shown that virtual experiments provide high results in the formation of students' conceptual understanding, error analysis, and repeated execution of experiments. Some studies emphasize that virtual laboratories should not completely replace real laboratory work, but should be used as a complementary tool.

Domestic studies note that virtual laboratories can partially eliminate the problem of lack of technical equipment in academic lyceums. This is especially important in the study of mechanics, electromagnetism, and atomic physics.

Active and competency-based approach. In recent years, the competency-based approach has been considered a leading paradigm in the literature. Studies based on the updated version of Bloom's taxonomy have shown that digital learning tools serve to develop higher-level cognitive skills - analysis, synthesis and evaluation. In physics, when project work, problem-based tasks and research activities are combined with a digital environment, students' scientific thinking develops significantly.

Table 1. Criteria and indicators for assessing research effectiveness

Evaluation criteria	Indicators	Pre-test and post-test
Level of knowledge	Correct and deep understanding of physics concepts	Pre-test va post-test
Practical skills	Quality of performing experiments and laboratory work	Practical tasks, rubric
Analytical thinking	Ability to solve problematic issues	Projects and problem tasks
Learning motivation	Interest and activity in the subject	Questionnaire, observation
Digital competence	Independent use of digital tools	Practical exercises, portfolio

This table provides a comparative analysis of the main components of the improved methodological model based on digital education with the traditional approach to teaching physics in academic lyceums. The table reveals the differences between the goals, content, methods, educational tools, student activity, assessment system and expected results, and the advantages of digital education are scientifically and pedagogically justified.

**Research discussion.** This study aimed to determine the effectiveness of the model for improving the methodology of teaching physics in academic lyceums based on digital learning. The results obtained during the pilot-testing process confirmed that digital learning tools and modern pedagogical approaches have a significant positive impact on the quality of physics education. This section analyzes the research results and discusses them in comparison with the existing scientific literature and pedagogical practice. First of all, the analysis of the pre-test and post-test results conducted between the experimental and control groups showed that the level of knowledge of students who participated in classes organized on the basis of digital learning was higher than that of students who received education based on traditional methods. In particular,

students' conceptual understanding of complex physical concepts - laws of mechanical motion, laws of conservation of energy and momentum, electromagnetic phenomena - was significantly strengthened. This is consistent with the importance of visualization and simulations in understanding abstract concepts, as noted in the literature.

During the study, the use of virtual laboratories and interactive simulations was an important factor in the development of students' practical skills. Students in the experimental group were more likely to make independent decisions when performing laboratory tasks, change the conditions of the experiment, and analyze the results. This confirms the effectiveness of the teaching process based on the constructivist approach. These results are consistent with the conclusions of foreign studies that virtual laboratories are an effective tool that complements real experiments. During the discussion, special attention was paid to the motivation and activity of students in learning. The results of the questionnaire and observation showed that in the digital learning environment, students' interest in the lesson, their activity in asking questions, and their desire to work independently increased. The introduction of flipped classroom and project-based teaching methods reduced students' passivity in the lesson and turned them into active creators of knowledge. This clearly demonstrates the practical results of the competency-based approach. The results of the study also had a positive impact on the professional activities of teachers. In the process of planning and conducting lessons based on digital education, teachers' technological and pedagogical competencies (TPACK) developed. Teachers gained new experience in selecting digital tools in the lesson process, adapting them to pedagogical tasks, and using them in the assessment process. At the same time, in some cases, initial difficulties of teachers in using digital technologies were identified, which indicated the need for constant methodological support and professional development. Another important aspect identified in the discussion of the study is the level of integration of digital educational tools into the teaching process. The results of the experiment showed that using technologies only as a substitute does not produce the expected effect. On the contrary, the quality of education increases significantly when digital technologies are raised to the higher stages of the SAMR model by redesigning the lesson process, creating problem situations, and organizing students' research activities. This conclusion is consistent with the theoretical views put forward in modern pedagogical literature. At the same time, some limitations were also observed during the study. In particular, factors such as the lack of technical infrastructure at all academic lyceums, the lack of internet speed and digital devices may hinder the full implementation of digital education. In addition, the level of digital literacy of students varies, which requires an individual approach to the lesson process. These limitations indicate the need to further improve the model in the future. In general, the discussion of the research results shows that the model of improving the methodology of teaching physics in academic lyceums based on digital education is of significant scientific and practical importance for increasing educational efficiency, deepening students' knowledge and skills, and preparing them for the requirements of a modern scientific and technological society. The results obtained also open up opportunities for the wider implementation of this model in the future and its adaptation to the education of other natural sciences.

**Conclusion.** In this scientific study, the issue of improving the methodology of teaching physics in academic lyceums based on digital education was analyzed from a scientific, theoretical and practical perspective, and an integrated methodological model was developed. The results of the study showed that combining traditional teaching methods with digital educational technologies

significantly increases the effectiveness of physics education. It was proven that the development of teachers' technological and pedagogical competencies is an important condition for the successful implementation of digital education. At the same time, it was found that students' motivation and activity increased, and their participation as active subjects in the lesson process was ensured. In conclusion, it can be said that the model of improving the methodology of teaching physics in academic lyceums based on digital education is of significant scientific and practical importance in improving the quality of education, forming modern knowledge and competencies of students, and thoroughly preparing them for higher education. In the future, it is advisable to adapt this model to other natural sciences, as well as continue research on further developing digital education infrastructure.

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