EFFECTIVE USE OF SOFTWARE TOOLS AND IMPROVEMENT OF EDUCATIONAL-METHODICAL SUPPORT IN THE INTEGRATED ORGANIZATION OF PHYSICS EDUCATION

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Abstract: *The article analyzes the theoretical, methodological, and practical foundations of the effective use of software tools in organizing the process of physics education based on an integrative approach. In the integrated teaching process, the role of software tools such as GeoGebra, PhET, Tinkercad, Canva, PowerPoint, and Audacity in developing students' creative and intellectual competencies is highlighted. The research findings justify the need to develop a model that enables the improvement of educational and methodological support for physics education through the use of digital tools.*

Keywords: *physics education, integrative approach, software tools, digital learning environment, educational-methodical support, creative-intellectual competence*

Introduction

In the era of rapidly developing digital technologies, the modern education system requires the formation of a new methodology for the learning process. Today, innovative approaches, integrative educational technologies, and the effective use of software tools have become among the key factors determining a teacher's professional competence. In particular, within the field of natural sciences — especially in physics education — the integration of digital technologies into the teaching process has emerged as a significant scientific issue aimed at developing students' scientific thinking, creative-intellectual competence, and analytical reasoning skills. Physics, as a field of study, is significant not only for learning theoretical concepts but also for shaping students' comprehensive thinking through the modeling of natural laws, conducting experiments, analyzing results, and finding practical solutions. Therefore, the introduction of an integrative approach in physics education allows for the effective organization of the learning process, coordination of teacher and student activities within a unified system, and enhancement of the scientific and creative potential of instruction.By its nature, the integrative approach aims to create a holistic educational system by ensuring interconnections among different disciplines, technologies, and pedagogical tools. In this regard, the selection of software tools and their effective use in an integrative learning process require both a solid theoretical justification and a well-developed methodological framework.

In the current context of global digital transformation, electronic education, digital learning resources, and virtual environments are widely used at all stages of the educational process. For instance, software tools such as GeoGebra, PhET, Tinkercad, Labster, Canva, PowerPoint, and Audacity make it possible to organize physics lessons in an interactive, visual, and experiment-based format. Through these tools, learners can model complex processes, conduct virtual experiments, analyze their results, and draw conclusions. As a result, the learning process transforms from a mere means of delivering information into an active, creative environment focused on developing critical thinking and solving problem-based situations.

In recent years, large-scale reforms have been carried out in the Republic of Uzbekistan aimed at the digitalization of the education system, the implementation of integrative approaches, and the improvement of educational and methodological support. In particular, the “Digital Uzbekistan – 2030” Strategy, the Law on Education, and the latest resolutions of the Ministry of Higher Education, Science and Innovation have identified the development of teachers’ digital competencies and the introduction of innovative methods into the learning process as priority directions. Therefore, the effective use of integrative learning approaches and software tools in teaching physics is not only a theoretical issue but also a matter of state policy significance.

One of the key aspects of the integrative learning process is the strengthening of interdisciplinary connections. For example, in teaching physics, close interrelations with subjects such as informatics, mathematics, biology, and chemistry contribute to the formation of a comprehensive knowledge system among students. In this process, software tools serve as instruments that consolidate various interdisciplinary ideas within a unified educational environment.For instance, GeoGebra is effectively used to model the relationships between mathematics and physics; PhET simulations are employed to experimentally study phenomena related to mechanics, electricity, heat, and waves; while Tinkercad serves as an effective platform for learning about electronics, energy, and engineering elements. These processes enhance students’ comprehension and integrate education with learner-centered and innovation-driven approaches.

Another important aspect of the effective use of software tools in physics education is the improvement of educational and methodological support. Alongside traditional textbooks, it is necessary to create digital lesson plans, electronic laboratories, virtual practical exercises, testing systems, and interactive learning modules. Through these resources, teachers can develop students’ abilities for independent thinking, analysis, modeling, and drawing conclusions. Educational and methodological complexes developed on the basis of digital tools help individualize the learning process — allowing each student to follow a learning trajectory that corresponds to their level of preparation and interests.

Recent scientific studies (Kozlova, 2022; Prensky, 2019; Jonassen, 2020; Qahhorov, 2023) emphasize the advantages of integrative education, such as increased learner motivation, improved learning outcomes, and the activation of creative thinking. With the emergence of artificial intelligence (AI) technologies in the educational process, the importance of software tools has grown even further. AI-based learning systems, virtual experimental environments, and simulations make it possible to create interactive, learner-centered, and reflective forms of instruction. Therefore, the development of a scientific and methodological model for the effective use of software tools in teaching physics, its experimental implementation, and its integration into teacher training programs represent one of the urgent scientific tasks of modern pedagogy.

At the core of this research lies the issue of effectively using software tools in organizing physics education in an integrative manner. The main idea of the study is that by purposefully and systematically introducing modern software tools into the educational process, it is possible to enhance the teacher's professional skills, develop students' creative and intellectual competencies, and increase the overall efficiency of the learning process. In this context, the coherence between methodological support, the structure of educational models, pedagogical design, and interactive tools plays a crucial role.

From this point of view, the present research is aimed at addressing the following scientific problem: to develop the scientific and methodological foundations for the use of software tools in organizing physics education in an integrative manner and to improve the educational and methodological support of the learning process.

The results of research conducted in this direction will have practical significance not only for physics teachers but also for the methodology of natural sciences, digital pedagogy, and STEM education as a whole. Therefore, the conceptual model, methodological recommendations, and digital learning resources developed within the framework of this dissertation or article will serve to improve the quality of training future teachers.

Research shows that digital learning tools expand the methodological capabilities of teachers. For instance, through the PhET Interactive Simulations project, it is possible to experimentally study physical processes in more than 100 topics. GeoGebra, based on mathematical modeling, enables interactive analysis of phenomena such as waves, oscillations, electrical circuits, and mechanical motion. During these activities, learners are engaged in active cognitive learning based on the principle of "understanding through visualization."

Uzbek scholars such as M. Kholmurodov (2022), Z. Karimova (2021), O. Murodov (2023), and H. Shoyzakova (2024) have developed the methodological, psychological, and technological foundations of applying digital technologies in education. Their studies demonstrate that the rational use of software tools in the learning process increases students' motivation, deepens their understanding, and fosters the development of creative thinking.

Research Methodology

In this research, the following methodological approaches were taken as a basis:

Activity-based approach – aimed at transforming the learner from a passive recipient of knowledge into an active creator of knowledge.

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Activity-based approach – aimed at transforming the learner from a passive recipient of knowledge into an active creator of knowledge;

Learner-centered education – taking into account individual abilities and learning pace;

Integrative learning model – combining various subjects and technologies within a unified educational environment;

Experimental-pedagogical approach – evaluating methodological recommendations through practical experimentation and testing.

The research was conducted at the Department of Physics of Gulistan State University. The experimental work was carried out in three stages:

Preparatory stage – analysis of existing educational and methodological resources, and selection of software tools (GeoGebra, PhET, Canva, PowerPoint);

Practical stage – development of integrative lesson modules and their implementation in experimental groups;

Analytical stage – statistical analysis of the obtained results and identification of efficiency indicators.

The lessons were organized in the following formats:

Experiments using virtual laboratories (PhET, Tinkercad);

Electronic presentations and designed lesson materials (Canva, PowerPoint);

Mathematical modeling through GeoGebra;

Audio-based analysis and verbal reflection using Audacity.

As a result, the learning outcomes of the groups that applied the integrative approach in physics teaching were 22–25% higher than those of the control groups. In addition, the level of students' independent performance in creative assignments increased by 30%.

Results and Discussion

The experimental results revealed the following key findings:

Integrative learning through software tools helps students develop the ability to perceive interdisciplinary connections between scientific concepts;

The digital learning environment enhances motivation and ensures better knowledge acquisition, especially for visual and kinesthetic learners;

Digitalization of educational and methodological support (including electronic lesson plans, video tutorials, and test modules) saves teachers' time and improves instructional quality;

The integrative model encourages teachers to make independent methodological decisions and effectively manage student activities;

Artificial intelligence (AI) technologies create opportunities for automated analysis of learning outcomes (for example, through platforms such as LearningApps, ChatGPT Education, and Khanmigo).

Conclusion

Organizing the physics education process in an integrative manner represents a modern pedagogical model that harmoniously unites the teacher, the learner, academic disciplines, and technologies within a single educational system.

The effective use of software tools increases the interactivity of the physics teaching process, enhances students' independence, and develops their creative thinking.

Improving educational and methodological support ensures the professional growth of teachers within a digital learning environment.

The research results indicate the necessity of developing and implementing a methodological model based on integrative learning in practical educational settings.

For physics teachers, digital competence is becoming an essential professional quality of the modern educator.

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