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TRANSFORMATION OF THE METHODOLOGY OF TEACHING DRAWING GEOMETRY AND SHADOW THEORY UNDER THE INFLUENCE OF AUGMENTED REALITY TECHNOLOGIES

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At the current stage of higher education development, the active introduction of digital technologies into the educational process necessitates revising traditional methodological approaches to teaching graphic disciplines. The relevance of this problem lies in the need to increase the efficiency of the development of spatial thinking among technical education students during the study of descriptive geometry and shadow theory, where the visualization of complex geometric processes is a key element of the educational activity. Limited opportunities to ensure a sufficient level of interactivity and clarity in traditional methods have led to the use of augmented reality (AR) technology as a tool for optimizing the educational process.

Modern research indicates an active search for effective ways to improve the graphic training of education students in the conditions of digitalization. In particular, the work of B. Wang substantiates the pedagogical model of using AR technologies in the training of future architects, which contributes to the development of technological competence and enhances the visualization of educational material [1]. Studies by I. M. Romanyshyn, O. V. Samborska, and N. A. Khmil confirm the effectiveness of AR/VR technologies in professional training, focusing on increasing motivation and the quality of knowledge acquisition [4].

The issue of spatial thinking development is evident in the works of S. S. Hurkovska, where methodological approaches to teaching engineering graphics and descriptive geometry are defined, but primarily within the framework of traditional or partially digitalized teaching aids [2; 3]. At the same time, the study by M. P. Tsoi demonstrates the positive impact of digital simulations on understanding the principles of linear perspective, which is closely related to issues in spatial modeling [5].

Despite the available developments, scientific sources do not sufficiently address the complex integration of AR technologies into teaching descriptive geometry and shadow theory. In particular, there are no systematic methods for using AR to visualize chiaroscuro processes and spatial constructions, which complicates the formation of a holistic spatial representation of students. This, in turn, necessitates further research to develop effective didactic models for the use of immersive technologies.

The transformation of the methodology for teaching descriptive geometry and shadow theory today is not just another educational trend but an objective necessity due to the digitalization of the educational environment. The introduction of AR technologies opens new opportunities to combine traditional approaches with modern visualization tools, but this process requires a balanced, methodically justified approach. It is important that digital tools do not replace classical methods, but complement them, while maintaining the logic of graphic training.

One of the key advantages of the updated methodology is interactive visualization, which allows you to work with geometric objects in a three-dimensional environment. Practice shows that the ability to perceive an object in space contributes to understanding complex constructions. At the same time, excessive visualization can reduce abstract thinking, as students begin to rely on ready-made models rather than independent analysis.

No less important is the dynamism of geometric processes enabled by AR technologies. Observing constructions in real time, especially when studying the theory of shadows, helps improve the quality of learning. However, there is a risk of focusing attention mainly on the visual aspect without sufficient awareness of the mathematical essence of the processes.

An important aspect is also the spatial integration of educational material. The combination of real and virtual environments creates an immersive effect that enhances learning motivation. At the same time, one should take into account the technical limitations of educational institutions, in particular the quality of equipment, access to devices, and software stability, which can affect the effectiveness of such an approach, especially in mass education. It is also important to consider the accessibility and ease of use of interfaces when performing practical tasks.

Separately, it should be noted that the high interactivity of immersive technologies is a factor in activating the cognitive activity of technical education students. The formation of practical skills is ensured by providing students with the opportunity to change the parameters of objects and experiment with forms, which contributes to the development of their analytical thinking. At the same time, there is a risk of dominance of form over content, which requires teacher control so that interaction does not become an end in itself in the learning process.

Increasing visibility is one of the key advantages of using augmented reality over traditional methods in teaching graphic and design disciplines. For example, when modeling shadows, students can track changes in real time, which enhances their understanding of the material. At the same time, simplifying the presentation should not lead to simplifying the content, since the fundamental principles should remain the basis of learning.

Another advantage of digital technologies is their ability to personalize the educational process. The ability to adapt the pace and complexity of tasks to the requirements and level of education seekers meets modern educational needs. At the same time, implementing such an approach requires more time and effort from the teacher, primarily in creating educational materials of varying complexity.

To summarize the main characteristics of the use of digital technologies in teaching graphic disciplines, it is advisable to present a systematic analysis (Table 1).

Table 1. Generalization of approaches to the use of digital technologies in teaching graphic disciplines

Integration direction	Technologies	Advantages	Limitations
Training of architectural specialists	AR	Increase in the level of visualization, development of professional competencies	Limited adaptation to teaching descriptive geometry and shadow theory
Engineering graphics	Partial digitalization	Systematic teaching, formation of basic skills	Insufficient interactivity
Descriptive geometry	Partial digitalization	Development of spatial thinking	Limited use of AR technologies
Professional training of teachers	AR/VR	Increase in motivation, interactivity	Lack of subject-oriented methods
Study of perspective	Digital simulations	Facilitate understanding of spatial processes	Does not cover chiaroscuro constructions

Source: compiled by the author

The data in the table shows that digital technologies are being widely introduced. However, their systematic use in teaching descriptive geometry and shadow theory is still underdeveloped.

It should be noted that the key principle in implementing AR technologies is expediency. The integration of digital tools should be subordinated to the educational goal, since without a clear methodological justification, even modern technologies may be ineffective.

Therefore, the introduction of augmented reality in teaching descriptive geometry and shadow theory has significant potential, but it is not a universal solution. Its effectiveness depends on pedagogical expediency, technical conditions and the level of teacher training. Further research should aim to develop methodologically sound models for integrating AR into the educational process.

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ARTIFICIAL INTELLIGENCE IN DESIGN: A REVOLUTION FROM IDEA TO IMPLEMENTATION

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In the context of contemporary digital transformation, artificial intelligence (AI) has become one of the key drivers of innovation across various fields, including design. Its integration into the design process is transforming traditional approaches to product development, optimizing workflows, and expanding the creative capabilities of designers. According to the OECD, AI is defined as a system capable of interpreting data, learning from it, and making decisions with a certain degree of autonomy [3]. In the field of design, this implies a shift from intuitive decision-making toward data-driven and generative approaches.

At the early stages of the design process, AI is активно used for the analysis of large-scale datasets (Big Data), enabling the identification of patterns in user behavior and the prediction of market trends. As noted by Brynjolfsson and McAfee, digital