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Methodology of using graphic software to enhance students' knowledge in technical drawing

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Abstract: The effect of metacognitive techniques on improving English instructors' capacity for independent learning is examined in this paper. The study presents a paradigm that incorporates metacognitive strategies including self-regulation, reflection, and strategic planning in recognition of the critical role that self-directed learning plays in professional development. A mixed-methods approach was used, using qualitative interviews to acquire a deeper understanding of instructors' experiences and quantitative surveys to evaluate changes in autonomous learning habits. The application of metacognitive techniques considerably enhanced teachers' capacity to assess their own learning processes, establish reasonable objectives, and modify their pedagogical approaches, according to the results.

Keywords: Self-directed learning, English teachers, metacognitive techniques, autonomous learning, and professional growth.

Introduction: The Action Strategy for the Development of the Republic of Uzbekistan outlines a priority task: “Further improvement of the continuous education system, expanding access to quality educational services, and continuing the policy of training highly qualified specialists in line with the modern needs of the labor market.” In fulfilling this task, higher education institutions play a key role in developing students' project design skills, spatial imagination, creative activity, and ability to solve practical problems related to the field. These qualities significantly contribute to increasing the effectiveness of graphic education.

The widespread use of computers by students serves as a foundation for the rapid advancement of science and technology, which in turn fosters socio-economic development. The implementation of modern teaching methods, computer and information-communication technologies in the educational process, equipping higher education institutions with modern laboratory equipment and teaching materials, supporting and promoting research and innovation activities, and establishing and developing modern scientific laboratories in schools are essential measures to prepare competitive professionals with high professional mobility and creativity.

The digitalization of various fields of human activity has led to significant transformations in long-standing pedagogical technologies. New teaching tools have necessitated a reassessment of key pedagogical issues: who should be taught in schools, what the content of education should be, and what forms and methods should be used as the foundation for training specialists in higher education.

Taking these factors into account, we consider it necessary to review the content of engineering computer graphics education, as it remains one of the pressing issues in teaching this discipline. In revising the content of engineering computer graphics, it is essential to consider the latest advancements in science and technology.

An analysis of research focused on the principles of teaching allows for the identification of didactic principles common to all subjects. While researchers agree on the list of these principles, their interpretation varies. These principles include:

- Principle of education and upbringing
- Principle of linking theory with practice
- Scientific principle

- Comprehensibility principle
- Consistency and coherence principle
- Consciousness and creative activity principle
- Visuality principle
- Principle of reinforcing learning outcomes and developing cognitive abilities
- Principle of considering individual characteristics of learners and collective learning
- Principle of positive emotional engagement in learning

If we divide the content and procedural aspects of education, traditional didactic principles can be conditionally classified into these two groups. The conditionality of this classification is due to their interconnection and mutual dependence. As an example, we can illustrate the necessity of distinguishing between the processes of education, upbringing, and development.

- Scientific principle
- Comprehensibility principle
- Consistency principle
- Continuity principle
- Systematic principle
- Principle of linking theory with practice
- Sustainability principle

Scientific Principle – M.D. Dammer outlined the development of the scientific principle's content. According to research findings, M.N. Skatkin in 1950 defined the content of this principle through eight key requirements:

1. The scientific reliability of the information provided to students.
2. Revealing the essence of the phenomena described.
3. Demonstrating the interconnections of phenomena.
4. Presenting phenomena in their development and highlighting the sharp characteristics of this development.
5. Introducing students to key theories that explain phenomena dialectically and materialistically.
6. Creating correct perceptions of the world and the power of human intellect.
7. Developing proper ideas about absolute and relative truth.
8. Introducing students to scientific research methods.

We agree with the views of Z.K. Meretukova and A.R. Chinazirova, who state that “the scientific principle in education should consider the fact of ‘scientific pluralism’ within the educational content. Different approaches to a single scientific problem expand students' thinking and encourage them to seek the truth.”

The conclusion drawn from G.M. Chernobelskaya's perspective is that "scientific content is achieved not only by providing students with ready-made knowledge but also by introducing them to scientific research methods."

One of the most fundamental principles of teaching is comprehensibility. When studying new material, students face challenges related to both the content of the information and the way it is presented. The first type of difficulty is associated with the student's thesaurus—i.e., the system of interrelated concepts that reflect their perception of the world. Such difficulties are known as "thesaurus information barriers." Since each student’s thesaurus is different, not all students will face the same barriers.

The comprehensibility principle in schools has been studied in O.V. Romanova's works. Examining the impact of new information environments on the learning process, the author argues that education should account for the fact that students independently acquire vast amounts of information from the global information field. As this principle evolves, the information students receive and transform into knowledge must be scientifically valid. Therefore, students should be able to distinguish genuine scientific knowledge from pseudo-scientific claims.

This principle is based on the following rules:

- The teaching process should consider students' social experiences.
- The learning process should be oriented toward solving socially, economically, ecologically, and politically important issues.
- There should be a close connection between education and industrial labor in the national economy.
- The use of mass media and periodical materials in teaching.

E.V. Eliseeva states that in modern conditions, consistency should be the leading principle in content selection: "It ensures a pedagogically justified system of interconnected learning materials." The consistency principle requires that educational content developers include knowledge that is part of the conceptual systems of the subject and reveal its essence.

Continuity Principle – I.P. Podlasiy notes that the learning process consists of sequential steps, and if it

progresses without interruptions, disruptions in continuity, or uncontrollable situations, it leads to greater success. If skills are not regularly practiced, they gradually fade.

The concepts of continuity and systematicity principles are explained in L.V. Zagrekova and V.V. Nikolina's Didactics: "The principles of continuity and systematicity require that the content of educational material be presented in a structured sequence and logical interrelation. In this process, new information builds upon previous knowledge and prepares students to grasp future content."

The principles considered for structuring educational content are closely related to the principle of sustainability, which directs content developers to account for interdisciplinary and intersubject relationships. "The excessive integration of interdisciplinary connections in the educational environment has significantly increased the demands on educators."

To bring the teaching of the "Technical Drawing" subject in line with modern requirements, it is essential to gather information on the topics outlined in the curriculum and process them using multimedia computer technologies. The application of modern computer technologies in the educational process should be conducted in parallel with pedagogical technologies rather than replacing them. Such an approach ensures the effective assimilation of graphic materials, leading to the expected outcomes. It would not be an exaggeration to say that the use of graphic software is the only way to achieve the desired results in teaching technical drawing.

The very nature of the subject demands instruction using graphic software.

Until recently, the main reasons for not integrating graphic software with technical drawing education were the lack of teachers proficient in such software and the inadequate state of classrooms. However, in today's advanced era, conducting lessons without using graphic software is entirely inconsistent with modern educational standards.

Ensuring the interconnection of topics in teaching technical drawing, maintaining their systematicity, and utilizing the most modern teaching methods and tools are among the pressing tasks of today. All topics within this subject serve as a foundation for each other, requiring teachers to engage in continuous self-improvement. This is because technical drawing, particularly in construction, evolves in tandem with industry changes. Consequently, preparing teachers who meet these requirements is another critical issue.

Modern computer technologies offer extensive capabilities for redrawing blueprints, adding animations, and converting them into multimedia formats. Multimedia representations of drawings capture students' attention, altering their attitude toward the subject. Additionally, such visuals provide students with a more comprehensive understanding of the drawing.

Modern software tools related to computer graphics, such as ArchiCAD, AutoCAD, 3ds Max, and others, serve as essential aids for teachers in delivering lessons. For students, these tools enhance their comprehension of the subject, improve spatial imagination, foster creative and logical thinking, and ultimately increase academic performance. Using computer graphics for processing gathered information is highly appropriate.

Computer graphics belong to the category of complex synthetic resources. It emerged and developed by integrating modern devices and technological solutions that help engineers bring innovative ideas to life through graphical representation.

Three-dimensional (3D) modeling is a journey into a world where a designer's ideas take realistic and convincing forms on a computer screen. It gives the impression that, by merely extending a hand, one could touch something that previously existed only in imagination.

In 3D modeling systems, a three-dimensional model typically appears on the monitor screen in arbitrary parallel projection (axonometry). The corresponding panel displays standard views, including orthogonal and standard isometric projections. To automatically generate orthogonal projections from a 3D model, the T-VIEW and T-DRAW commands are used. In this way, the task of directly constructing a geometric representation of a spatial object (3D model) in a two-dimensional plane (monitor screen) is accomplished.

Geometric modeling consists of the following four components:

1. Original object or modeling subject. In three-dimensional space modeling, orthogonal projections, axonometry, perspective, and numerical marked projections are obtained on a monitor screen. Additionally, modeling objects may include multidimensional and nonlinear models, which remain relevant and unresolved challenges in modern science.

2. Model field – the medium where the model is displayed. Typically, this is the monitor screen, but other methods can also be used for visualization.

3. Modeling apparatus determines the methods used to represent 3D models. These include:

o Analytical

- Kinematic
- Constructive
- Parametric
- Mixed methods

4. Model types are categorized into wireframe, surface, and solid models.

Displaying a 3D drawing created using computer graphics software in video format allows students to perceive it as a real-life object, making it easier to understand and enhancing their spatial imagination. The development of spatial visualization skills is crucial for understanding technical drawing since it plays a key role in mastering the subject. Only students with strong spatial visualization abilities can successfully complete technical drawing assignments.

Modern graphic software significantly expands modeling possibilities, making it convenient to create building models. Using these tools for illustrating images, views, sections, stairs, roofs, joints, structures, cost estimation, and other topics fosters the development of students' spatial imagination and creative thinking skills.

A subject teacher can create project works related to topics using ArchiCAD and apply them in lessons. By leveraging ArchiCAD's extensive capabilities, teachers can view models from different angles, apply section views, change model colors, automatically assign dimensions, and take advantage of many other features.

The most essential requirement is that the teacher must be proficient in computer graphics and select appropriate graphic software based on the content, complexity, and didactic objectives of the material.

Students studying construction technical drawing should acquire the following knowledge and skills:

- The history of computer graphics
- The branches of computer graphics
- Systems forming the field of engineering graphics (CAD, CAM, CAE)
- Graphic software working within CAD systems and their operating principles
- Electronic image formats
- Equipment panels used for drafting drawings
- Algorithms for generating drawings based on an object's spatial position
- Analysis of tool panels designed for creating 2D and 3D graphics
- Creating a 2D drawing of a given 3D part
- Constructing a 3D model based on a 2D drawing
- Determining optimal algorithms for designing geometric models in 2D and 3D spaces
- Creating complex drawings and shapes in 2D and 3D
- Developing skills in drafting and printing drawings
- Analyzing objects with complex shapes
- Comparing manual drafting (using traditional drawing tools) and CAD-based drafting
- Comparing two or more CAD programs
- Identifying similarities and differences between CAD software
- Developing self-learning abilities to master new CAD programs independently

We believe that acquiring these competencies is essential for students pursuing construction technical drawing.

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