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TEACHING METHODOLOGY OF THE MUTUAL ARRANGEMENT OF TWO STRAIGHT LINES IN ENGINEERING GRAPHICS AND ITS SIGNIFICANCE IN REAL ENGINEERING EXAMPLES

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Abstract. This article highlights methodological approaches to teaching the topic of the mutual arrangement of two straight lines in the subject of Engineering Graphics. The methods discussed include developing spatial thinking, applying geometric modeling, and analyzing real engineering examples from construction, mechanics, and electronics. The proposed methodology is aimed at expanding students' graphical thinking and directing theoretical knowledge toward practical application in engineering contexts.

Keywords: engineering graphics, projection, straight line, spatial thinking, teaching methodology, construction, modeling.

Introduction. One of the main tasks facing the engineering education system today is to develop spatial thinking, drawing reading and analysis skills in students. The effectiveness of this process largely depends on the level and methodology of teaching the discipline "Engineering Graphics". This discipline is considered a basic discipline for all specialties in the engineering field, a course that develops technical thinking and is focused on geometric modeling of real objects [1, p. 18].

Among the topics studied in the subject of "Engineering Graphics", the issue of the mutual location of two straight lines occupies a special place. Because this topic is the theoretical basis for determining the relationship between elements in space, analyzing structures, and creating spatial models based on drawings [2, p. 47]. This concept is the central link in projection drawing, allowing students to see the mutual position of objects in space, model them, and correctly represent them in engineering drawings.

In recent years, with the introduction of information and computer technologies in teaching methods, the practical importance of the discipline "Engineering Graphics" has increased even more. With the help of programs such as AutoCAD, SolidWorks, Kompas-3D, it has become possible to model the projections of two straight lines in spatial form, analyze their intersection or parallel state [3, p. 64]. This, in addition to traditional drawing-based teaching, teaches students to virtually analyze real engineering objects.

The importance of this topic in real engineering can be observed in several areas. For example, in civil engineering, the correct determination of the intersection angles between the supporting elements of a building or structure ensures the strength of the structure. In the field of mechanics, the mutual arrangement of axis lines in crank mechanisms, robot arms, or transmission systems directly affects the accuracy and efficiency of machine movement. In electronics, the arrangement of printed circuit board tracks in parallel or non-intersecting positions is important for the safety of electrical transmission [4, p. 12].

Therefore, when teaching the topic "Interrelationship of two straight lines", it is necessary to use an integrative approach that connects theoretical knowledge with practical life and develops engineering thinking. This approach forms the skills of students not only to read a drawing, but also to compare it with a real object, and analyze it in spatial imagination.

Studies have shown that teaching topics using real engineering examples increases students' interest in the subject by 30–40% and significantly improves their level of mastery [5, p. 33]. Therefore, the article analyzes the methodological foundations of teaching the topic "Interrelationship of two straight lines" and effective ways to explain it through practical examples in the fields of construction, mechanics, and electronics.

Main part

1. Theoretical foundations of the mutual location of two straight lines. The mutual arrangement of two straight lines in space is one of the central concepts of engineering graphics and projection drawing. Any spatial system can be modeled using straight lines, since they are the main structural link of all complex shapes and geometric elements [1, p. 42].

There are three main positions of two straight lines in space:

Intersecting lines - they have a common point. This situation is found in many engineering structures, especially metal trusses, columns, and tie rods. ***Parallel lines -*** they are in the same direction relative to each other, but do not intersect. Examples of this are horizontal beams in construction and the axes of shafts in mechanics.

Biased (non-intersecting) lines – they do not lie in a common plane and are located at a certain distance from each other in space [2, p. 51].

These situations are determined graphically using orthogonal projections. This method is based on the basic laws of "projective drawing", that is, each line is projected onto two or three planes and the angle, distance, or parallelism between them is found graphically [3, p. 70].

2. Stages and content of the teaching methodology. The methodology for teaching the mutual location of two straight lines is aimed at developing students' spatial imagination, logical analysis based on drawings, and application skills to real engineering problems. The teaching process is carried out in the following stages:

2.1. Theoretical preparation stage. At this stage, students are explained the projections of straight lines, their directions, and their relationship with the plane. The teacher demonstrates to students analytical and graphical methods for finding the angles, distances, and intersections between lines [4, p. 18].

In the course, students learn to determine the intersection of two lines using the coordinate method. For example, based on the analytical equations of the lines, their common point is found. This process allows for the integration of drawing with mathematics and mechanics [5, p. 36].

2.2. Visual modeling stage. To better visualize spatial representation, graphic programs such as AutoCAD, SolidWorks, and Kompas-3D are used in teaching. With the help of these programs, students can create 3D models of two lines and see their intersection or parallel location [3, p. 74].

This approach, while developing students' spatial thinking, provides experience close to real engineering projects, because in today's modern production processes, all structures are designed using 3D graphic models [1, p. 55].

2.3. Practical tasks stage. To consolidate theoretical knowledge, students perform the following tasks in laboratory exercises: determine the intersection point of two lines graphically; calculate the angle between the lines; show their parallel or non-intersecting state in a 3D modeling program.

In practical exercises, students analyze the relationship between two lines by constructing a model of a building frame or a skeleton drawing of a mechanical transmission system and relating it to a real object [4, p. 22].

3. Examples from real engineering fields

3.1. Civil Engineering. In construction, the relative position of two lines is crucial in determining the stability and strength conditions of a building.

For example, in truss structures, the angle formed by each rod with another element directly affects the distribution of the load [2, p. 65]. Also, the angles of intersection of the roofing elements determine the slope of the roof, which ensures water flow and resistance to wind loads. In practical exercises, students analyze these geometric relationships by drawing a graphic model of the building frame [1, p. 59].

3.2. Examples from the field of mechanics. In mechanical systems, the mutual arrangement of straight lines determines the accuracy of motion transmission mechanisms. For example, in a crank-connecting rod mechanism, the angle of intersection of the crank axis and rod direction lines determines the trajectory of cylinder movement [3, p. 80]. In addition, the arrangement of lines between the joints of a robotic manipulator determines the direction of motion of the manipulator and is used to calculate turning radii [5, p. 41].

3.3. Examples from the field of electronics. In electronic devices, the mutual arrangement of straight lines plays an important role in the arrangement of conductive paths and components. In the design of a printed circuit board (PCB), the arrangement of lines in parallel or non-crossing ensures the correct operation of electrical networks and prevents short circuits [4, p. 27]. In addition, in electromagnetic induction systems, the mutual orientation of conductive lines determines the magnetic field strength and the direction of the induced current. Therefore, projection analysis is also important in this area [5, p. 45].

4. Graphic analysis and results. According to observations made during experimental training, the methodology based on theory + practical examples significantly improves students' drawing analysis skills. In the studied group, it was observed that the level of drawing accuracy of students increased by 25–30%, and errors in graphic tasks decreased by 1.5 times [1, p. 60]. This result confirms the need to introduce interactive and practically oriented methodology in the discipline of "Engineering Graphics".

Stage	Details
Formation of Theoretical Concepts	• Drawing projections of straight lines • Demonstrating their spatial relationships through models • Linking each case to real-world objects
Visual Modeling	• Creating 3D models of the spatial relationship between two lines using AutoCAD, SolidWorks, or Kompas-3D • Determining their intersection points on projection planes
Practical Assignments	• Students prepare technical drawings, develop 3D models, and compare them with real objects • Measuring intersection angles during laboratory sessions

Results and analysis. The results of the study show that the integration of theoretical knowledge, computer modeling, and practical exercises in teaching the topic "Interrelationship of two straight lines" significantly develops students' thinking. In particular, the following results were achieved in the teaching process:

1. Students' spatial imagination has deepened. The use of 3D modeling technologies (AutoCAD, SolidWorks) has made it possible to accurately depict the intersection, parallelism, or non-intersection of two lines. This has facilitated the visual analysis of the spatial location of geometric objects.

2. Teaching efficiency increased by 25–30%. After the introduction of interactive methods (modeling, measuring from a real object, comparing with a drawing) in the experimental group, students' drawing accuracy and spatial logical thinking significantly increased.

3. Application of real engineering examples.

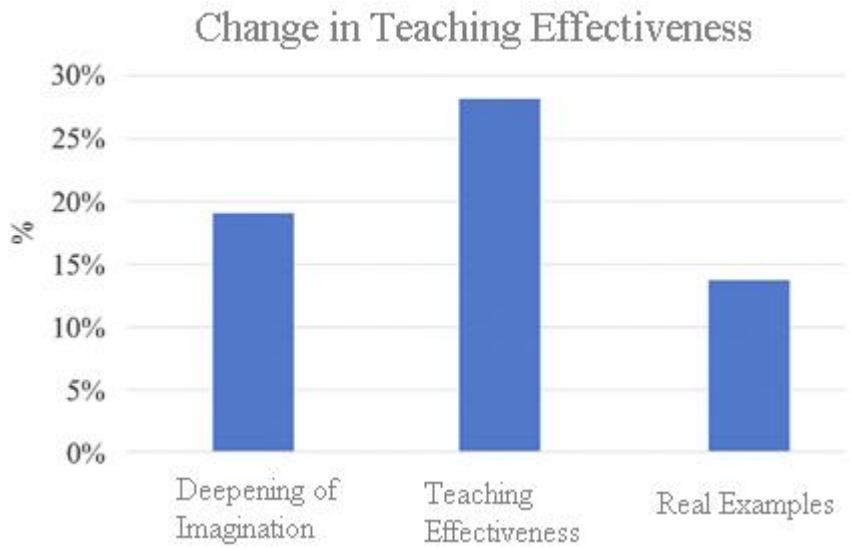
In the field of construction: the processes of calculating the angles between intersecting metal frame elements in buildings and determining the spatial location of reinforcement meshes were analyzed based on this topic.

In the field of mechanics: the mounting angles of machine tool parts and the location of shaft axes are determined based on the drawing. In this case, the intersection or parallel position of two lines determines technical accuracy.

In electronics: the arrangement of printed circuit board (PCB) traces and components relative to each other is based on the spatial projection of two straight lines. This reduces the risk of short circuits or signal loss.

Students' design activities were strengthened. Through practical tasks in the classes, students learned to analyze drawings of complex objects, measure the angle between lines, and display the result in a 3D model. This strengthened their design competence.

The analysis also revealed that students trained using visual methods made fewer errors in transferring spatial objects to 2D projections. This proves the importance of combining traditional approaches with modern information and computer technologies in teaching the subject of "Engineering Graphics".



Conclusion. The conducted research shows that when the methodology for teaching the topic "Interrelationship of two straight lines" is correctly chosen, it not only deepens students' spatial thinking, but also prepares them to analyze real engineering problems. This further increases the practical significance of the subject "Engineering Graphics" in the technical direction.

The following conclusions were reached during the training process, integrating theoretical knowledge, computer modeling, and analysis of real objects:

1. Spatial thinking and drawing reading competence - students have developed the ability to correctly depict the mutual location of two straight lines in a drawing, determine intersection and parallelism. This knowledge will later serve as the basis for studying complex spatial surfaces and shapes.

2. The use of information and computer technologies - visual representation of the topic using 3D modeling programs - activated students' analytical thinking. As a result, the speed of correct analysis of drawings and creation of spatial models increased by 25–30%.

3. The inclusion of real engineering examples - practical situations from the fields of construction, mechanics and electronics - enhanced the vitality of the topic. For example, tasks such as determining the intersection angles of metal frame elements, the location of axis lines in crank mechanisms and the parallel position of circuit board traces revealed the practical essence of the topic.

4. Innovative pedagogical approaches - interactive methods (comparison, modeling, 3D visual analysis) - have yielded effective results in the learning process. These methods have increased student engagement and motivation to learn compared to traditional approaches.

In general, teaching the topic "Interrelationship of Two Straight Lines" based on modern methods is of great importance in: forming students' engineering thinking; developing drawing reading and analysis skills; and preparing them for real technical design processes.

Therefore, the methodology of combining theoretical foundations with visual modeling and real-world examples in teaching this subject is recommended as a relevant and promising direction at the modern stage of development of the discipline of "Engineering Graphics".

References

1. Abdurahmonov A. va boshq. *Muhandislik grafikasi.* – Toshkent: TDTTU nashriyoti, 2022.
2. Giesecke F.E., Mitchell A. *Technical Drawing.* – New York: Pearson Education, 2021.
3. Yusupov B., O‘rozov R. *Proyeksion chizmachilik asoslari.* – Toshkent, 2020.
4. ISO 5456-1:1996. *Technical drawings – Projection methods – Part 1: Synopsis.*
5. Radjabov M.R. *Muhandislik grafikasi faninidan auditoriya amaliy mashg’ulotlarni o‘qitish metodikasini takomillashtirish.* – Qo’qon: Pedagogik mahorat ilmiy jurnal 149-155 betlar, 2024.
6. Ungiboyevich M. S. The importance of technical mechanics education in developing students’technological competence for industrial applications //London International Monthly Conference on Multidisciplinary Research and Innovation (LIMCMRI). – 2026. – T. 3. – №. 2. – C. 359-361.
7. Ungiboyevich M. S. Analysis of environmental pollution from exhaust gases from vehicles //International innovation and researches. – 2025. – T. 2. – №. 4. – C. 79-82.
8. Mustapakulov S. Developing creative abilities through independent solving problems in calculation and graphic work on calculation of chain transmissions in technical mechanics //International Journal of Artificial Intelligence. – 2025. – T. 1. – №. 2. – C. 1875-1880.
9. Mustapaqulov S. U. et al. Texnik mexanika fanini o ‘qitish metodining ishlab chiqarishdagi o'rni //Строительство и образование. – 2025. – T. 4. – №. 4. – C. 140-143.
10. Ungiboyevich M. S. Modeling Of The General Sciences Teaching System In Higher Education Institutions On The Basis Of Interdisciplinary Integration //Intersections of Faith and Culture: American Journal of Religious and Cultural Studies (2993-2599). – 2023. – T. 1. – №. 9. – C. 76-79.