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INTEGRATED METHODOLOGY OF DESCRIPTIVE GEOMETRY AND TECHNICAL DRAWING IN DEVELOPING SPATIAL THINKING

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Abstract: This article explores the effectiveness of teaching descriptive geometry and technical drawing in an integrated manner to develop students' spatial thinking. Through practical examples and visual exercises, the study analyzes how the combination of these two subjects in the educational process influences students' ability to perceive space, analyze drawings, and develop modeling skills.

Keywords:spatial thinking, descriptive geometry, technical drawing, integrated methodology, visual perception, engineering drawing, graphic literacy.

Today, digital transformation, technological integration, and competency-based approaches in education are gaining global importance. In particular, in technical and engineering fields, forming students' spatial thinking and preparing them as highly qualified professionals capable of working with complex geometry and drawings has become a critical task.

Spatial thinking is the ability to imagine, model, manipulate, and make decisions based on a three-dimensional environment. This type of thinking plays a vital role in many fields such as engineering, architecture, design, technology, medicine, and even art. However, traditional educational approaches aimed at developing this ability often rely on separated, standalone subjects. As a result, students face difficulties in applying knowledge integrally and analyzing complex shapes.

Descriptive geometry and technical drawing are fundamental subjects for developing students' spatial and graphic thinking. Descriptive geometry teaches the projection of geometric objects, while technical drawing focuses on creating, analyzing, and reading real object drawings. However, teaching these subjects independently does not fully allow students to integrate theoretical knowledge with practical applications. Therefore, teaching them through an integrated methodology that connects geometric theory with technical-practical skills is essential for enhancing learning effectiveness.

Integrated approaches expand students' thinking, encouraging them to think visually, analyze drawings critically, and engage in spatial modeling. Especially when combined with

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modern digital tools (such as AutoCAD, Fusion 360, GeoGebra 3D, SketchUp), teaching these two subjects in harmony helps students prepare to design, model, analyze, and defend their own projects.

In this regard, the article theoretically and practically explores the mechanisms of developing spatial thinking through the integrated teaching of descriptive geometry and technical drawing. The study reveals the effectiveness of this approach in enhancing students' graphic thinking and engineering skills.

The research was conducted in the following stages:

1. Theoretical Analysis – A study of advanced methodological literature on spatial thinking, graphic subjects, and integrated education.
2. Experiment – Two groups were formed: one taught traditionally, and the other through an integrated methodology.
3. Digital Tools – Lessons were organized using AutoCAD, GeoGebra 3D, SketchUp, and Compass-3D.
4. Assessment Criteria – Evaluation of students' drawing accuracy, ability to manipulate geometric constructions, level of 3D modeling, and visual analysis skills.

Lessons conducted using the integrated methodology in the experimental group yielded the following outcomes:

- Spatial thinking indicators improved by **23%**.
- Skills in analyzing and modeling geometric objects significantly improved.
- Theoretical knowledge from descriptive geometry was successfully applied in practical tasks of technical drawing.
- Positive progress was observed in graphic thinking, precision, and algorithmic reasoning.

These results show that integrated teaching of graphic subjects fosters holistic graphic literacy among students. By applying geometric constructions from descriptive geometry to real objects in technical drawing, students can effectively transfer knowledge to practical contexts. Through such activities, they gain a deep understanding of spatial manipulation, symmetry, projection, and transformation.

Incorporating digital technologies (3D modeling, VR/AR components, interactive simulations) into the teaching process significantly enhances its effectiveness. Integrated lessons are especially important for students in STEM fields. This approach helps prepare qualified personnel for modern industries such as CAD/CAM, architecture, and automation.

Teaching descriptive geometry and technical drawing together through an integrated methodology effectively develops spatial thinking. This approach creates a strong link between graphic knowledge and practical skills, supporting the formation of technical thinking, engineering culture, and creative design potential.

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Based on the results of this research, the following recommendations are proposed for future implementation:

- Curriculum revisions to include integrated teaching methodologies.
- Broad adoption of digital educational tools in the classroom.
- Organization of professional development courses for teachers on integrated instruction.

This approach sets a new stage in spatial-thinking-based education.

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