

**THE ROLE OF TECHNICAL DRAWING IN DEVELOPING STUDENTS'
LOGICAL THINKING SKILLS: AN INTERDISCIPLINARY INTEGRATION
APPROACH**

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Abstract: This article analyzes the role of technical drawing (engineering graphics) in developing students' logical thinking skills within the framework of interdisciplinary integration. The study highlights how technical drawing classes contribute to the development of students' thinking, enhancement of spatial imagination, and formation of an analytical approach to solving technical problems. It also demonstrates that integrating technical drawing with computer science, mathematics, and technology expands the didactic potential of the subject and improves learning outcomes.

Keywords: Technical drawing, logical thinking, interdisciplinary integration, engineering education, visual thinking, graphic knowledge, cognitive development, teaching methodology.

In contemporary engineering and technical education, developing students' logical thinking, analytical reasoning, and problem-solving skills is becoming an increasingly urgent pedagogical task. These competencies are central to professional readiness because modern technical practice requires not only knowledge of formulas and standards, but also the ability to interpret complex systems, detect patterns, anticipate consequences, and justify decisions. Logical thinking in technical fields is expressed through structured reasoning, step-by-step analysis, accuracy, and the capacity to transform abstract information into concrete solutions. For this reason, education increasingly prioritizes disciplines that can simultaneously build conceptual understanding and train thinking operations such as comparison, classification, deduction, induction, modeling, and verification.

Technical drawing occupies a special position in this context. Unlike subjects that remain primarily theoretical, technical drawing serves as a bridge between conceptual reasoning and visual representation. It develops students' spatial imagination, graphic reasoning, and the ability to express engineering solutions in a clear visual language. When students learn to read and create technical drawings, they work with a system of rules and conventions that requires attention, precision, and logical consistency. Every line, dimension, projection, and symbol carries meaning and must be placed correctly. This creates a natural environment for training systematic thinking: students must understand the object as a whole, break it into parts, identify relationships, and then reconstruct it accurately in a graphical form. In this process, logical thinking is not taught separately; it is developed through repeated practice embedded in real tasks.

Technical drawing is also inherently problem-oriented. Students frequently face tasks that demand reasoning under constraints, such as reconstructing a 3D object from orthographic views, correcting errors in projections, determining missing dimensions, or choosing the appropriate section and scale. These tasks strengthen analytical reasoning because learners must apply geometric logic, follow standards, and test their interpretations. At the same time, they develop problem-solving habits: clarifying the problem, identifying given data, selecting a method, constructing a solution, checking results, and explaining decisions. Such habits are directly

aligned with the competence profile expected of future engineers, architects, designers, and technologists.

By its nature, technical drawing is closely integrated with mathematics, computer science, physics, and technology. Mathematical knowledge supports geometric constructions, measurement, proportionality, and transformations. Physics contributes understanding of forces, motion, structure, and functional constraints that influence design. Technology and engineering disciplines provide practical contexts where drawings become tools for production and implementation. Computer science strengthens digital literacy and algorithmic thinking, especially when CAD systems and 3D modeling are introduced. This interdisciplinary connection is not accidental: technical drawing is a universal professional language that unites multiple domains of technical knowledge. As a result, when technical drawing is taught in isolation, students may master drawing techniques but fail to see deeper connections. Conversely, when it is taught through interdisciplinary integration, students begin to understand how knowledge interacts, which strengthens their logical reasoning and supports holistic competence development.

Interdisciplinary integration is particularly valuable because it helps learners transfer skills from one context to another. For example, a student may use mathematical reasoning to construct accurate projections, apply computational thinking to organize drawing steps systematically, and use technological understanding to interpret the functional purpose of components. This transfer is a sign of deep learning: knowledge becomes usable, not merely stored. Therefore, the purpose of this study is to determine the role of technical drawing in shaping students' logical thinking, evaluate the effectiveness of an interdisciplinary integration approach, and provide practical recommendations for improving teaching practice in technical and engineering education.

This study aimed to identify how technical drawing contributes to the formation of students' logical thinking skills when taught through interdisciplinary integration. A mixed-method design combining qualitative and quantitative approaches was used to ensure a more reliable and comprehensive interpretation of outcomes. Both practical and theoretical data were collected and analyzed to identify not only the level of change, but also the mechanisms that explain how and why that change occurs. The research was structured around several core components.

First, practical trials were conducted to observe changes in students' thinking abilities after introducing interdisciplinary integration into the learning process. During these trials, teaching was organized through interactive lessons, group work, and project-based activities. Interactive learning formats were selected because they stimulate active reasoning: students are required to explain, defend, compare, and revise their ideas rather than simply reproduce information. Group work allowed the study to observe how learners negotiate solutions, distribute tasks, and justify choices. Project-based learning was used to strengthen the applied dimension of technical drawing by connecting tasks to real or simulated professional problems, such as creating a drawing package for a simple product, designing a structural element, or building a 3D model from 2D views.

Second, various data collection tools were applied to assess logical thinking and analyze learning products. Tests and problem tasks were used to measure specific thinking operations such as identifying relationships, selecting correct projection methods, completing missing elements, and detecting logical inconsistencies. In addition, students' creative works were analyzed with attention to drawings, diagrams, and the quality of analytical approaches embedded in solutions. This component was necessary because technical drawing is best evaluated not only through correct answers but also through the reasoning process: the sequence

of steps, selection of tools, accuracy of construction, and justification of decisions. The analysis of drawings and models provided insight into how students applied logic in practical tasks.

Third, statistical analysis was conducted to evaluate the effectiveness of interdisciplinary integration. Comparative procedures were applied to compare outcomes across groups and to identify patterns in performance growth. Measures such as mean values and dispersion were used to understand not only average improvement but also the stability of results across students. This allowed the study to identify whether the integration approach produced consistent benefits or whether improvement was limited to particular learners.

Fourth, observation and document analysis were used to examine the curricular and methodological foundations of technical drawing instruction. Curricular materials, textbooks, and teachers' methodological resources were reviewed to identify the extent and quality of interdisciplinary connections already present in content and lesson design. Observation during lessons focused on students' engagement, reasoning behaviors, use of terminology, accuracy of drawings, collaboration quality, and responses to problem-based tasks. Document analysis helped reveal whether integration was systematic and planned or episodic and informal.

Based on the findings, the study identified effective methods and techniques for developing logical thinking through technical drawing and formulated recommendations for improving interdisciplinary instruction.

The results of the research revealed several important findings. First, technical drawing proved to be a strong tool for developing spatial thinking and logical reasoning. When students represent an object in a drawing, they learn to analyze its structure, proportions, and functional relationships. They must interpret the object as a system rather than a collection of parts. This requires identifying the logic of geometry and construction: what is visible, what is hidden, how parts connect, and how dimensions control form and function. In practice, students gradually shift from surface-level drawing to analytical representation, where every element is justified by the object's structure and by technical standards.

Second, interdisciplinary integration of technical drawing with mathematics and computer science increased students' cognitive activity. In integrated lessons, students demonstrated higher levels of reflective thinking and graphic analysis. They showed stronger teamwork skills and greater confidence in proposing and testing solutions. Integration helped students connect geometric principles with drawing procedures and understand digital modeling as an extension of manual drawing logic rather than a separate skill. This strengthened learning motivation because students could see clear applications and meaningful links between disciplines.

Third, in the experimental group, enriching technical drawing lessons with elements of mathematics and physics increased independent problem-solving performance by approximately 30–35 percent according to survey results. This improvement suggests that integration supports not only knowledge acquisition but also the development of learning autonomy. Students became more capable of solving tasks without continuous teacher guidance, which is a key indicator of logical thinking development. They were more likely to select appropriate methods, justify their steps, and correct mistakes through self-checking.

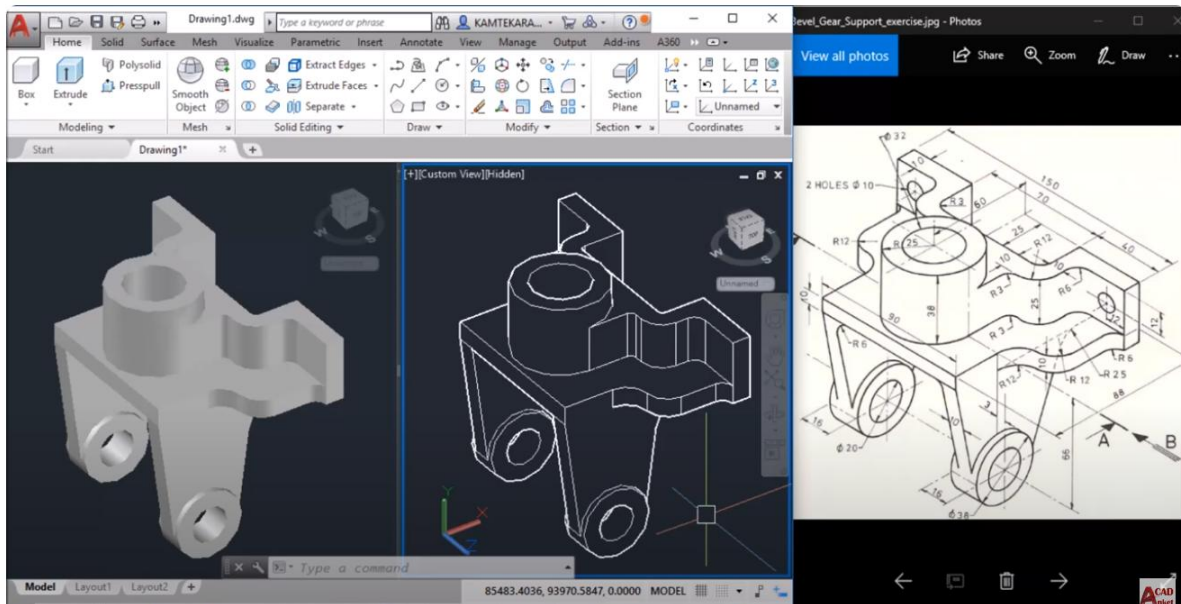
Fourth, the use of digital tools such as AutoCAD, KOMPAS, and SolidWorks significantly activated students' analytical thinking and improved their ability to transform 2D representations into accurate models. Digital environments require learners to operate with constraints and parameters, which strengthens logical reasoning. For example, a student must consider coordinate systems, layers, constraints, and geometric dependencies. Unlike manual drawing, where errors can remain unnoticed until later, digital tools often expose inconsistencies immediately, forcing learners to revise assumptions and improve accuracy. This continuous feedback supports deeper learning and reinforces disciplined problem-solving.

The discussion of results indicates that technical drawing should not be taught as an isolated subject, but as a component of an integrated interdisciplinary approach. Lessons enriched with mathematics, computer science, and geometry create meaningful cognitive links in students' thinking. These links stimulate logical reasoning because learners must apply knowledge across contexts, compare methods, and justify decisions. Integration also supports the formation of a systems perspective: students begin to understand how design decisions interact with function, structure, technology, and constraints.

Developing graphic reasoning strengthens students' capacity to analyze spatial problems, visualize alternative solutions, and propose justified design decisions. This becomes a crucial foundation for future professional growth in engineering, architecture, design, and technology. When students can translate an idea into a correct drawing and then into a 3D model, they demonstrate a full cycle of technical reasoning: conceptualization, representation, verification, and communication. In professional contexts, these competencies reduce errors, increase productivity, and improve the quality of technical documentation.

Integrated instruction should be implemented through practical sessions, interactive teaching methods, and systematic use of digital technologies. Practical sessions enable repeated application of logic in real tasks. Interactive methods stimulate communication, reflection, and argumentation. Digital technologies provide tools for modeling, simulation, and rapid verification. Together, these components create a learning environment where logical thinking is continuously practiced, evaluated, and strengthened.

Based on the drawing referred to as Figure 1, three logical perspectives can be formed that



illustrate how technical drawing supports logical thinking. First, understanding relationships between shapes and dimensions requires logical reasoning. Students learn to analyze designs step by step, identify dependencies, and apply correct dimensioning rules, which reduces mistakes and improves efficiency. Second, logical thinking directs students toward creative problem-solving. In technical drawing, it is not enough to follow instructions; students must search for new solutions, test alternatives, and choose optimal variants based on constraints and standards. This encourages flexible reasoning supported by evidence. Third, technical drawing provides an interactive and practical foundation for forming logical thinking because drawings enable learners to visualize abstract concepts and express them precisely. This strengthens independent thinking and the ability to justify decisions through clear representation.

Creating a 3D virtual model based on a given technical drawing is the process of generating a three-dimensional representation of an object by using computer tools while taking into account shape, dimensions, and geometric properties specified in the drawing. This process requires the learner to interpret projections, reconstruct spatial relationships, and verify consistency between 2D and 3D forms. It therefore functions as a powerful learning activity for strengthening logical reasoning and analytical control.

In conclusion, this study analyzed the role of technical drawing in developing students' logical thinking skills and examined the effectiveness of an interdisciplinary integration approach. The results demonstrate that technical drawing is not only a means of delivering technical knowledge but also a powerful instrument for developing systematic and logical reasoning. Interdisciplinary integration expands students' knowledge and enhances their ability to solve problems by connecting concepts across mathematics, computer science, physics, and technology.

The alignment between 3D modeling and traditional technical drawings helps students understand the subject more deeply and promotes creative and critical thinking. Interactive teaching methods and modern software tools strengthen logical thinking skills by increasing engagement, enabling continuous feedback, and supporting applied learning. As a result, teaching technical drawing through interdisciplinary integration can be recommended as an effective method for developing students' logical thinking. This approach also contributes to improving the competence of future engineers and preparing them for professional work in modern technological environments.

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