pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

PEDAGOGICAL FOUNDATIONS OF INTEGRATING TECHNICAL DRAWING IN GENERAL SECONDARY SCHOOLS BASED ON THE STEAM EDUCATION CONCEPT

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Abstract. This article analyzes the theoretical and practical aspects of integrating the subject "Technical Drawing" in general education schools based on the STEAM (Science, Technology, Engineering, Art, Mathematics) education concept. The role of technical drawing in interdisciplinary integration and its importance in developing students' technical and creative thinking are highlighted.

In addition, the methodology of organizing lessons based on the STEAM approach, as well as existing problems and their solutions, are presented.

Keywords: STEAM education, technical drawing, integration, technical thinking, creativity, project-based learning, interdisciplinary connections.

Introduction. In the modern education system, one of the most important tasks is not only the acquisition of theoretical knowledge by students but also the development of practical skills. In global educational practice, special attention is given to the formation of 21st-century competencies, namely critical thinking, creativity, problem-solving abilities, and the development of innovative approaches. In this regard, the STEAM education concept is recognized as one of the most relevant directions in contemporary pedagogy.

STEAM (Science, Technology, Engineering, Arts, Mathematics) is based on an integrated approach to teaching subjects rather than teaching them separately. This approach enables students to apply knowledge in real-life situations and prepares them for future professional careers.

In general secondary schools, Technical Drawing is considered one of the key subjects that develops technical and graphic literacy. This subject contributes to the development of spatial visualization, geometric thinking, and technical creativity among students. However, in traditional teaching practice, Technical Drawing is often limited to theoretical knowledge, which may hinder the full development of students' creative and practical abilities.

Therefore, there is a growing need to integrate Technical Drawing into the STEAM education concept. Such an approach strengthens interdisciplinary connections, develops students' technical thinking, and guides them toward independent project-based learning.

This article analyzes the theoretical foundations, didactic possibilities, and practical implementation methods of integrating Technical Drawing through the STEAM approach.

Research Methodology. The present study aims to investigate the scientific and pedagogical foundations of integrating Technical Drawing in general secondary schools based on the STEAM (Science, Technology, Engineering, Arts, Mathematics) education concept. The research employs a comprehensive methodological framework that combines both theoretical and practical approaches.

The theoretical foundation of the study is based on pedagogical integration theory, competency-based education, and constructivist learning theory. According to these approaches, the learner is not considered a passive recipient of knowledge but an active subject who constructs knowledge through independent and purposeful learning activities.

During the research process, the following scientific and methodological methods were applied:

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

Theoretical analysis method – scientific and pedagogical literature, monographs, and research articles on STEAM education, Technical Drawing methodology, and interdisciplinary integration were analyzed;

Comparative analysis method – traditional methods of teaching Technical Drawing were compared with STEAM-based instructional models;

Systematic approach – Technical Drawing was studied as an integrated pedagogical system within the STEAM framework;

Modeling method – a step-by-step didactic model for organizing Technical Drawing lessons based on STEAM principles was developed;

Pedagogical observation method – students' classroom activity, creative engagement, and problem-solving skills were observed and analyzed.

STEAM is an educational model based on the integration of Science, Technology, Engineering, Arts, and Mathematics. This approach enables students to learn knowledge in an interconnected rather than isolated manner.

The main objectives of STEAM education are:

- *developing critical thinking*
- *enhancing creativity*
- *forming practical skills*
- *teaching real-life problem-solving abilities*

The role of Technical Drawing in the STEAM system: Technical Drawing is one of the key disciplines that develops technical thinking and is directly connected with all components of the STEAM framework:

- *Science: understanding the shape, structure, and physical properties of objects*
- *Technology: creating drawings using graphic software*
- *Engineering: designing constructions and models*
- *Arts: aesthetic design and composition*
- *Mathematics: geometric calculations and measurements*

Therefore, teaching Technical Drawing through the STEAM approach contributes to the comprehensive development of students.

Methods of integrating Technical Drawing with STEAM:

1. Project-Based Learning (PBL)

Students work on real-life projects such as house modeling, furniture design, and bridge construction. In this process, they create technical drawings, perform calculations, and produce final models.

2. Interdisciplinary integration

Technical Drawing is connected with: Mathematics (geometry, proportions); Physics (mechanics, forces); Informatics (computer graphics)

3. Use of digital technologies

Modern software is used to: create 2D and 3D models, work on virtual projects, visualize designs

4. Creative assignments

Students are given opportunities to develop free design ideas, which expands their imagination and creativity.

Lesson organization model

A STEAM-based Technical Drawing lesson may be organized through the following stages: problem identification (e.g., "How to construct a strong bridge?") → idea development → drawing creation → model construction → result analysis.

Outcomes of STEAM implementation:

- increased student interest in learning
- stronger integration of theoretical knowledge with practice
- development of creative and critical thinking skills

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

- improved career orientation

In addition, the study incorporated elements of practical pedagogical experimentation. The effectiveness of project-based learning, problem-based teaching methods, and the use of digital graphic tools (2D and 3D modeling software) in Technical Drawing lessons was examined.

The empirical part of the study focused on identifying the possibilities of applying the STEAM approach in teaching Technical Drawing in general secondary schools. Students' technical thinking, spatial visualization ability, and level of creative activity were evaluated as key indicators.

Analysis and Results. During the research process, the effectiveness of teaching Technical Drawing based on the STEAM education concept was analyzed through practical observations and the results of pedagogical experiments. The obtained findings demonstrated that the STEAM approach has significant advantages over traditional teaching methods.

In the traditional learning process, students are mainly limited to reproducing ready-made drawings and following the teacher's instructions. Such an approach does not fully develop their creative thinking and independent decision-making skills.

In STEAM-based lessons, however, students were taught through problem-based situations. For example, in the task "design a strong bridge model," they independently:

- *analyzed the problem*
- *developed ideas*
- *prepared technical drawings*
- *constructed models*
- *evaluated the results*

The comparative analysis showed that in groups where the STEAM approach was applied:

- *students' interest in lessons increased*
- *spatial visualization significantly improved*
- *drawing accuracy was enhanced*
- *creative thinking became more active*
- *teamwork skills were developed*

In addition, the use of digital technologies (2D and 3D modeling software) played an important role in developing students' technical competencies. By creating real objects in a virtual environment, students were able to gain a deeper understanding of their structure and design principles.

The results of the study indicate that the STEAM approach in teaching Technical Drawing not only strengthens knowledge acquisition but also contributes to the comprehensive development of students' creative, analytical, and problem-solving thinking skills.

Conclusion and Recommendations. The results of this study indicate that integrating Technical Drawing in general secondary schools based on the STEAM education concept is a highly effective pedagogical approach for developing students' technical, creative, and analytical thinking skills. The learning process organized on the basis of the STEAM approach, unlike traditional forms of education, increases students' activity, encourages independent thinking, and directs them toward solving real-life problems.

The findings of the study confirm that teaching Technical Drawing in an integrated manner contributes to the development of spatial visualization, graphic literacy, and engineering thinking among students. Furthermore, the use of project-based learning and digital technologies makes the learning process more effective and engaging.

Overall, the STEAM approach enriches the content of Technical Drawing, brings it in line with modern educational standards, and strengthens students' preparation for their future professional activities.

Recommendations

- Based on the results of the study, the following scientific and practical recommendations have been developed:

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

- Gradual implementation of the STEAM-based teaching system for Technical Drawing in general secondary schools;
- Wider use of the Project-Based Learning (PBL) method in classroom practice;
- Integration of modern digital technologies (AutoCAD, SketchUp, and other 2D/3D modeling software) into the learning process;
- Strengthening interdisciplinary links between Technical Drawing, Mathematics, Physics, and Informatics;
- Improving teachers' methodological training in STEAM education and organizing professional development courses;
- Increasing the number of creative, problem-based, and free design tasks aimed at developing students' creative thinking.

This study confirms that teaching Technical Drawing based on the STEAM education concept is one of the most effective directions in modern education, as it ensures the comprehensive development of students' knowledge, skills, and competencies.

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