Advances in Educational Technology and Psychology (2024)
Clausius Scientific Press, Canada
DOI: 10.23977/aetp.2024.080520
ISSN 2371-9400 Vol. 8 Num. 5

# *From Traditional to Digital: Transforming and Optimizing Mechanical Drawing Education*

**Xinli Xu[a,*,#], Wenbo Zhu[b,#], Haiyuan Li[c]**

*School of Mechanical Engineering, University of Shanghai for Science and Technology, Shanghai, China*
*[a]xuxinli@usst.edu.cn, [b]teacherzwb@163.com, [c]lhyni@sina.com*
*[#]Co-first author*
*[*]Corresponding author*

***Keywords:*** Mechanical Drawing, Digital Transformation, CAD Software, Project-Based Learning, Online Collaboration, Engineering Education

***Abstract:*** Mechanical drawing is a fundamental aspect of mechanical engineering education, providing students with the skills to create and interpret technical drawings that communicate design ideas. However, traditional teaching methods often rely on manual drafting tools and rote memorization, which can limit student engagement and hinder their development of critical thinking skills. This paper presents a study that explores the transformation and optimization of mechanical drawing education by transitioning from traditional to digital methods. The study involved implementing a novel approach that incorporated computer-aided design (CAD) software, project-based learning, and online collaboration tools into the curriculum. The results indicate that this digital approach significantly improved student motivation, understanding, and overall learning outcomes.

## 1. Introduction

Mechanical drawing is a fundamental subject in mechanical engineering curricula, providing students with the necessary skills to create and interpret technical drawings. These drawings are used to communicate design ideas, specifications, and manufacturing requirements. Traditional teaching methods in mechanical drawing have relied on manual drafting tools such as pencils, rulers, and compasses, and have emphasized rote memorization of drawing standards and techniques. While these methods have been effective in teaching the basics of mechanical drawing, they may be limiting in terms of engaging students and fostering the development of critical skills necessary for success in the field.

In recent years, the advent of digital technologies has transformed various industries, including education. The integration of digital tools and technologies into teaching and learning has the potential to enhance student engagement, improve learning outcomes, and foster the development of critical skills. This paper explores the transformation and optimization of mechanical drawing teaching modes from traditional to digital approaches, proposing a novel approach that leverages CAD software, project-based learning, and online collaboration tools.

## 2. Literature Review

Integrating digital technologies into mechanical drawing education brings several benefits. It enhances student engagement by providing interactive and visually appealing learning materials. Digital tools, such as CAD software, enable students to develop practical skills and proficiency in creating accurate and detailed technical drawings. The potential benefits of integrating digital technology into mechanical drawing education are mainly reflected in the following aspects:

Enhanced Accuracy and Precision: CAD software offers a range of tools specifically designed for precise drawing and dimensioning. These tools enable students to create technical drawings with a high level of accuracy and detail, significantly reducing the likelihood of errors[1]. By utilizing CAD software, students can easily modify and adjust dimensions, ensuring that their drawings adhere to strict specifications and standards. This enhanced accuracy and precision not only improves the quality of the technical drawings but also instills a strong sense of attention to detail in students, which is crucial for success in the field of mechanical engineering. Overall, the integration of CAD software in mechanical drawing education leads to more accurate and reliable technical drawings, ultimately benefiting both students and the industry.

Improved Visualization and Spatial Reasoning: CAD software revolutionizes the way students approach mechanical drawing by allowing them to create 3D models and visualize complex designs. This capability significantly enhances their spatial reasoning and understanding of technical drawings. With the ability to rotate, zoom, and view designs from different angles, students can gain a deeper comprehension of the spatial relationships between various components and how they fit together. This enhanced visualization promotes a more intuitive understanding of technical drawings, making it easier for students to interpret and create them accurately. By developing their spatial reasoning skills through the use of CAD software, students become more adept at solving complex design problems and envisioning the final product. Overall, the integration of CAD software in mechanical drawing education leads to improved visualization and spatial reasoning abilities, empowering students to excel in their field[2].

Increased Student Engagement and Motivation: Digital tools have the potential to transform mechanical drawing education by making it more interactive and engaging for students. Traditional methods of teaching mechanical drawing often rely on static images and textbook explanations, which can be limiting in capturing students' interest. However, by incorporating digital tools such as CAD software and interactive simulations, educators can create a dynamic and immersive learning environment. These tools allow students to actively participate in the learning process, experiment with different designs, and see the immediate results of their actions. This hands-on approach fosters a sense of curiosity and exploration, making mechanical drawing more enjoyable and motivating for students. As students become more engaged and interested in the subject, they are more likely to develop a deeper understanding and appreciation for the field of mechanical engineering. Therefore, the integration of digital tools in mechanical drawing education plays a vital role in increasing student engagement and motivation, ultimately leading to better learning outcomes[3].

Despite these findings, there is a lack of research on the transformation and optimization of mechanical drawing teaching modes from traditional to digital approaches. This paper aims to address this gap by proposing a novel approach that integrates CAD software, project-based learning, and online collaboration tools into mechanical drawing courses.

## 3. Methodology

CAD software is a digital tool used for creating and modifying technical drawings. It offers several advantages over traditional manual drafting tools, including increased accuracy, speed, and

ease of modification. In the proposed approach, students will be taught how to use CAD software to create and interpret technical drawings. This will enable them to develop a deeper understanding of design concepts and improve their ability to create accurate and detailed drawings.

This study employed a case study approach to evaluate the effectiveness of transforming mechanical drawing education from traditional to digital methods. Conducted in a university setting, it involved a sample of 50 mechanical engineering students enrolled in a sophomore-level mechanical drawing course.

The study followed a quasi-experimental design, comparing the performance of two groups: a control group receiving traditional instruction and an experimental group receiving instruction based on the digital approach. The latter involved the following elements:

(1) CAD Software Integration

Students utilized industry-standard CAD software to create and modify technical drawings, replacing manual drafting tools.

(2) Project-Based Learning

Students worked on projects that required them to apply their CAD skills to solve real-world engineering problems, fostering hands-on experience and critical thinking.

(3) Online Collaboration

Students used online collaboration tools to share files, communicate with peers, and receive feedback on their work, promoting teamwork and collaborative learning.

(4) Data collection included

Student performance on exams and assignments: This measured student understanding of mechanical drawing concepts and their ability to apply CAD software to create accurate and detailed technical drawings.

(5) Student feedback surveys

Surveys gathered student perceptions regarding the effectiveness of the digital approach, their engagement levels, and the impact on their learning.

(6) Observations of classroom activities

Observations assessed student engagement and collaboration during class sessions.

## 4. Findings and Discussion

The study's findings revealed significant improvements in student engagement, understanding, and overall learning outcomes among the experimental group receiving instruction based on the digital approach, which is mainly reflected in the following aspects:

(1) Increased Student Engagement

Student feedback surveys indicated significantly higher levels of engagement in the course compared to the control group. Students found the use of CAD software and the project-based learning activities to be more stimulating and motivating. CAD software enabled students to swiftly and accurately complete technical drawings, significantly improving work efficiency compared to manual drafting methods.

(2) Improved Student Performance

The experimental group demonstrated significantly higher scores on exams and assignments than the control group. Students were encouraged to experiment with different design parameters and observe the immediate feedback provided by the software. This iterative process of design and refinement not only honed their mechanical drawing skills but also cultivated their problem-solving abilities and CAD proficiency. This suggests that the digital approach effectively facilitated student learning and the development of both mechanical drawing skills and CAD proficiency.

(3) Enhanced Spatial Reasoning and Visualization

By engaging with the software, students were able to rotate, zoom, and section 3D models, enabling them to view objects from different angles and perspectives. This capability not only facilitated a better comprehension of spatial relationships but also allowed for a more nuanced understanding of the intricate details present in technical drawings. The use of CAD software allowed students to visualize and manipulate 3D models, significantly enhancing their spatial reasoning skills and understanding of complex technical drawings.

(4) Improved Problem-Solving Abilities

Through project-based learning, students were presented with authentic engineering challenges that demanded creative and innovative solutions. They had to analyze complex problems, break them down into manageable parts, and devise effective strategies to address each component. This process necessitated the use of critical thinking skills, as students had to evaluate different approaches, consider potential obstacles, and make informed decisions. Increased Collaboration and Teamwork: Online collaboration tools facilitated teamwork and communication among students, enabling them to share ideas, provide feedback, and work together on projects, promoting collaborative learning and professional communication skills.

These findings highlight the effectiveness of transforming mechanical drawing education from traditional to digital methods in creating a more engaging, effective, and collaborative learning environment.

## 5. Limitations and Future Research

This study has several limitations:

(1) Sample Size: The relatively small sample size limits the generalizability of the findings.

(2) University Setting: The study was conducted in a specific university setting, and the results may not be directly applicable to other contexts.

(3) Resource Availability: The success of this approach depends on access to computers, software, and technical support, which may not be available in all educational settings.

Future research can address these limitations and explore further:

(1) Larger Sample Size: Conducting studies with larger sample sizes in different educational settings would strengthen the generalizability of the findings.

(2) Long-Term Impact: Investigating the long-term impact of the digital approach on student learning and career outcomes would provide valuable insights.

(3) Integration of Emerging Technologies: Exploring the potential of integrating emerging technologies, such as augmented reality (AR) and virtual reality (VR), into mechanical drawing education.

## 6. Conclusion

This study demonstrates the effectiveness of transforming mechanical drawing education from traditional to digital methods. The findings suggest that this digital approach enhances student engagement, develops critical thinking and problem-solving skills, promotes collaborative learning, and improves overall learning outcomes. While this study highlights the potential benefits of this approach, further research is needed to validate these findings and explore the long-term impact on student success. By incorporating these best practices, educators can empower future mechanical engineers with the essential skills to excel in a rapidly evolving technological world.

## Acknowledgements

This work was supported by 2023 Undergraduate Teaching Research and Reform Project of

University of Shanghai for Science and Technology (Office of Academic Affairs, University of Shanghai for Science and Technology [2023]5); 2023 Construction Project of Undergraduate Demonstration Course with Ideological and Political Content (Office of Academic Affairs, University of Shanghai for Science and Technology [2023]18); 2023 Shanghai Municipal Level First-Class Undergraduate Courses (Shanghai Education Commission [2024]2).

## References

*[1] Jonassen, D. H. (2006). Learning to solve problems with technology: A constructivist perspective. In R. E. Mayer (Ed.), The Cambridge handbook of multimedia learning (pp. 293-316). Cambridge University Press.*
*[2] Liao, Y. (2018). Integrating computer-aided design into mechanical drawing education: A case study. Computer Applications in Engineering Education, 26(4), 642-652.*
*[3] Roy, A., & Bhandari, N. (2020). Engaging engineering students through CAD software in a technical drawing course. Journal of Engineering Education, 109(1), 131-144.*