DOI: 10.70491/jeptira.v3i2.100

Workshop on Technical Drawing Using AutoCAD Mechanical for High School and Vocational School Teachers

Ade Supriatna*[1], Didik Sugianto[2], Sarah Isniah[1], Gita Prawesti[1]
[1]Department of Industrial Engineering, Faculty of Engineering, Darma Persada University, East Jakarta 13450, Jakarta, Indonesia
[2]Department of Mechanical Engineering, Faculty of Engineering, Darma Persada University, East Jakarta 13450, Jakarta, Indonesia
*e-mail: ades74.as@gmail.com[1]

Abstract

Mastery of technical drawing is an important skill in the world of education, especially in the field of engineering, including for high school teachers or equivalent who teach vocational fields such as mechanical engineering, automotive, and machining design. AutoCAD Mechanical as a Computer-Aided Design (CAD) software provides various features that facilitate the creation of technical drawings according to international standards. This community service activity aims to improve teachers' competency in creating technical drawings using AutoCAD Mechanical, so that they can integrate these skills into the learning process. The training was attended by 20 teachers from various vocational and general high schools. The implementation method included material delivery, demonstrations, and direct practice with instructor guidance. The results of the activity showed that 85% of participants were able to create 2D and 3D technical drawings according to ISO standards with an accuracy level above 90%. This training is expected to improve the quality of learning in schools, so that graduates have engineering design competencies relevant to industry needs.

Keywords*: Engineering Drawing, AutoCAD Mechanical, Mechanical Design, CAD*

1. INTRODUCTION

Current industrial technology developments demand a workforce with high-level, precise, and standardized engineering design skills. The transition to Industry 4.0 places significant pressure on vocational education systems to integrate advanced digital literacy and practical technical competencies [1, 2]. In secondary education, teachers play a crucial role in equipping students with these skills. Technical drawing is a universal language in engineering, and has shifted dramatically from manual methods to computer-based Computer-Aided Design (CAD) [3].

The integration of CAD tools is no longer optional but a fundamental necessity for vocational graduates to remain competitive in the global market [4, 5]. Mastery of digital engineering tools is critical for bridging the gap between theoretical knowledge taught in schools and the practical demands of the industrial sector [6]. Furthermore, continuous professional development for teachers in advanced digital tools is highlighted as a key factor in improving the overall quality of technical education and ensuring curriculum relevance [7, 8].

AutoCAD Mechanical is a CAD tool equipped with a library of standard components, mechanical symbols, and automation features to accelerate the design process. Mastery of this tool will increase teacher efficiency in creating teaching materials and equip students with design technology used in industry [9]. However, based on initial observations, many high school teachers, particularly those teaching engineering subjects, still have limited mastery of AutoCAD Mechanical. This impacts the quality of learning and the skills acquired by students. Therefore, this community service activity was carried out to provide training in engineering drawing creation using AutoCAD Mechanical specifically for high school teachers or equivalent [10].

DOI: 10.70491/jeptira.v3i2.100

2. METHODOLOGY

The implementation method for this community service activity is designed to achieve the primary objective of improving the competency of high school teachers or equivalent in creating technical drawings using AutoCAD Mechanical. The method was selected by considering.

1. Participant Characteristics - Most participants were engineering teachers who already understood the basics of manual engineering drawing, but were unfamiliar with using AutoCAD Mechanical.
2. Industrial Competency Needs - Today's workforce demands mastery of CAD technology as a mandatory skill in engineering and manufacturing [11].
3. Learning Effectiveness - Based on adult learning theory (andragogy), an approach that emphasizes hands-on training will provide more optimal results than purely theory-based learning.

Therefore, the method used combines interactive lectures, live demonstrations, and individual practice guidance, with a structured flow from concept introduction to application in case studies.

A. Mentoring and Discussion
   i. During the practical sessions, instructors assisted each participant in overcoming technical difficulties.
   ii. Participants were divided into small groups to support each other.
   iii. A question-and-answer session was held at the end of each day to discuss challenges encountered and solutions for implementation in schools.

B. Evaluation and Assessment
   i. Pre-test: Measure participants' initial abilities by creating simple technical drawings manually or digitally.
   ii. Post-test: Measure skill improvement by creating 2D and 3D technical drawings based on case studies.
   iii. Comparative analysis of pre-test and post-test scores to assess training effectiveness.
   iv. Distribute questionnaires to assess participant satisfaction with the training materials, methods, and facilities.

C. Follow-up
   i. Provide training certificates to participants who pass the evaluation.
   ii. Provide training module files in PDF format for use as teaching materials in their respective schools.
   iii. Establish a communication group (WhatsApp/Telegram) as a forum for continued discussion between participants and instructors.

3. RESULT AND DISCUSSION

After the entire series of technical drawing training activities using AutoCAD Mechanical were completed, evaluation data was collected to measure the level of achievement of the activity's objectives. Data was obtained through pre-tests, post-tests, direct observation during the training, and the technical drawings produced by the participants. Analysis of this data was used to assess the effectiveness of the applied training methods, identify any obstacles encountered, and formulate recommendations for similar activities in the future.

A. Participant Profile and Activities

DOI: 10.70491/jeptira.v3i2.100

The training was attended by 20 teachers from various vocational high schools (SMK) and equivalent public high schools (SMA) in the Jakarta and Bekasi areas. The majority of participants were from the Mechanical Engineering and Automotive Engineering departments, while the remainder taught Technology and Engineering subjects. Most participants were familiar with the general version of AutoCAD, but had never used AutoCAD Mechanical specifically.

B. Training Results

1. Technical Skills Improvement

Evaluation is carried out by comparing the participants' pre-test and post-test scores.

i. Pre-test: Only 6 out of 20 participants (30%) were able to create simple digital engineering drawings correctly.

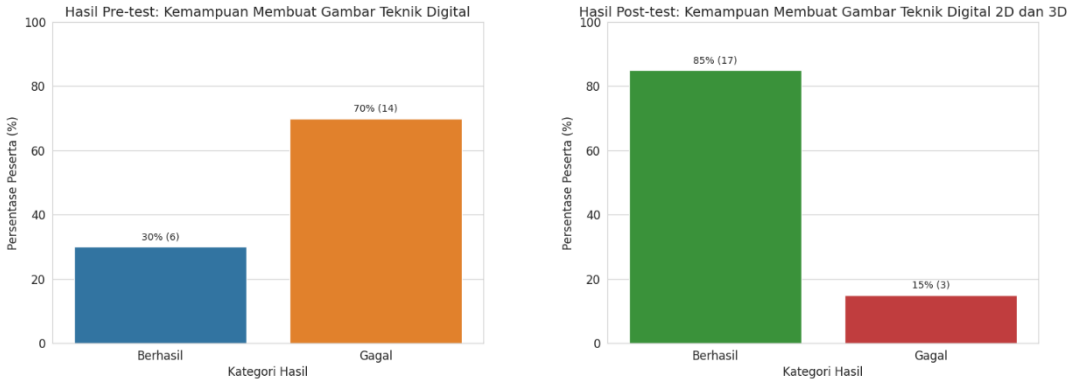

Figure 1. Pre & Post Test Result Score

ii. Post-test: As many as 17 out of 20 participants (85%) were able to create 2D and 3D engineering drawings according to ISO standards with dimensional accuracy ≥ 90%.

This improvement shows that hands-on practice-based training is effective in improving participants' skills.

2. Product Image Results

Participants are able to produce

i. 2D orthographic projection working drawing of a simple mechanical component.
ii. 3D isometric view drawing using the extrude and revolve features.
iii. Drawing with mechanical symbols, dimensional tolerances, and technical descriptions according to standards.

3. Supporting Skills

In addition to technical skills, participants also gain skills.

i. Organize templates and worksheets according to ISO standards.
ii. Use the built-in symbol and mechanical component libraries in AutoCAD Mechanical.
iii. Manage design files for school learning purposes.

4. Obstacles Faced

Some of the obstacles that arose during the training.

i. Differences in participants' initial abilities mean longer mentoring time for beginners.
ii. Inadequate computer specifications on some devices result in slow 3D image rendering.
iii. Some participants are still accustomed to manual drawing methods, requiring time to adapt to digital methods.

5. Problem Solving Strategy

To overcome these obstacles, the following steps are taken.

i. Participants were divided into small groups with a combination of experienced and beginner teachers.
ii. Adjusted AutoCAD Mechanical display settings to reduce graphical load.
iii. Provided a quick guide (cheat sheet) containing important AutoCAD Mechanical commands to speed up adaptation.

6. Discussion

A technical drawing training program using AutoCAD Mechanical for high school teachers or equivalent has significantly improved the participants' competency. Evaluation results showed a skill improvement, from only 30% of participants being able to create simple digital technical drawings before the training to 85% being able to create 2D and 3D technical drawings in accordance with ISO standards with high accuracy after the training.

The implementation method, which combines interactive lectures, live demonstrations, and case study-based practice, proved effective for participants with engineering backgrounds. In addition to improving technical skills, this activity also broadened participants' horizons in integrating CAD technology into the learning process at their respective schools.

This community service activity is expected to have a sustainable impact by improving the quality of technical drawing instruction at the high school level, enabling students to acquire competencies relevant to the demands of modern industry. For future activities, further training is recommended, including topics on assembly drawing, mechanical motion simulation, and optimizing the use of industrial component libraries.

4. CONCLUSION

A technical drawing training program using AutoCAD Mechanical for high school teachers or equivalent has significantly improved the participants' competency. Evaluation results showed a skill improvement, from only 30% of participants being able to create simple digital technical drawings before the training to 85% being able to create 2D and 3D technical drawings in accordance with ISO standards with high accuracy after the training.

The implementation method, which combines interactive lectures, live demonstrations, and case study-based practice, proved effective for participants with engineering backgrounds. In addition to improving technical skills, this activity also broadened participants' horizons in integrating CAD technology into the learning process at their respective schools.

This community service activity is expected to have a sustainable impact by improving the quality of technical drawing instruction at the high school level, enabling students to acquire competencies relevant to the demands of modern industry. For future activities, further training is recommended, including topics on assembly drawing, mechanical motion simulation, and optimizing the use of industrial component libraries.

REFERENCES

[1] E. S. Madsen, A. Bilberg, and D. G. Hansen, “Industry 4.0 and digitalization call for vocational skills, applied industrial engineering, and less for pure academics,” Jan. 2016, [Online]. Available:https://portal.findresearcher.sdu.dk/en/publications/industry-40-and-digitalization-call-for-vocational-skills-applied

[2] R. Yanuardi, I. Widiaty, and M. Komaro, “Vocational High School Technical Skills Facing the Industrial Era 4.0,” Jan. 2022, doi: 10.2991/assehr.k.220305.006.

[3] Ansori and Sofi, Desain 3D Dengan AutoCAD 2015, Jakarta: Kompas Gramedia, 2013.

[4] Mejias, J. G. (2016). Herramientas CAD/CAE/CAM en la malla curricular de PNF de Ingeniería Mecánica del IUTEB. 4(1). https://doi.org/10.1234/RRP.V1I1.92

[5] M. Tomovic, W. Szaroletta, and B. Harding, “Using 3 D Cad As A Tool To Integrate Topics Across The Curriculum,” Jun. 2001, [Online]. Available: https://peer.asee.org/9958.pdf

[6] S. Zeytunyan and A. Hajian, “Integrating design and manufacturing tools into Ilmenau Interactive Hybrid Online Lab,” International Conference on Remote Engineering and Virtual Instrumentation, pp. 227–230, Apr. 2014, doi: 10.1109/REV.2014.6784262.

[7] M. TIAN and W. FENG, “Teaching Reform of Vocational CAD Courses and Innovation by Product Design”, doi: 10.3969/j.issn.1672-8963.2012.01.017.

[8] Adnan, M. F., Daud, M. F., Saud, M. S., & Rauf, A. (2024). Contextual Knowledge Framework in CAD Education from the Perspectives of Practicing Engineers. Journal of Advanced Research in Applied Sciences and Engineering Technology. https://doi.org/10.37934/araset.46.1.6374

[9] M. D., Engineering Drawing from First Principles Using AutoCAD, London: Butterworth Heinemann, 2023.

[10] Ramadhan and Ali, "Pelatihan Penggunaan Program AutoCAD 2 Dimensi Sebagai Dasar Membuat Gambar Terukur Untuk Lulusan SMU Dan Sederajat Di Kabupaten Tangerang," Jurnal Abdi Masyarakat, vol. 1, no. 1, 2015.

[11] Autodesk, AutoCAD Mechanical User Guide, Autodesk Inc., 2024.