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Implementation of experiential learning method in mechanical drawing course to enhance student understanding through real projects

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Abstract: This research explores the implementation of experiential learning to improve students' understanding and skills in mechanical drawing using CAD software. We used this approach to identify challenges in learning mechanical engineering, including lack of time to learn CAD, suboptimal mechanical drawing skills, and limitations in producing details of mechanical components. Through a quasi-experiment with experimental and control classes, we measured the impact of the experiential learning method on improving conceptual understanding and practical skills in mechanical drawing. The results show that this approach is effective in improving students' understanding of detailed drawings and practical skills. The implementation of Experiential Learning also improved students' cognitive learning outcomes and psychomotor skills in mechanical drawing. The findings highlight the importance of adaptive and technological approaches to engineering education that are aligned with modern industry needs.

Keywords: Computer Aided Engineering; Mechanical engineering education; Quality education; Technical drawing

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1. Introduction

Understanding and implementing mechanical drawing skills is at the core of mechanical engineering education. Mechanical drawing is an essential visual representation in the design and production of mechanical components, so this skill must be mastered by mechanical engineering students (Syahril et al., 2020, 2022, 2021). However, traditional learning methods focusing on theory are often less effective at connecting theoretical knowledge with practical applications, especially in the context of mechanical drawing, which requires in-depth understanding and practical skills to produce accurate and functional designs (Akyazi et al., 2020; Chiarello et al., 2021). Accordingly, the Experiential Learning method is relevant as it allows students to learn through direct experience and more focused practice (Morris, 2020). This approach improves students' technical skills and helps them develop a more holistic understanding of the overall process of mechanical design and production.

The Experiential Learning method, introduced by David Kolb, emphasizes active learning through direct experience (D. A. Kolb, 1984). This method involves four stages: concrete experience, observational reflection, abstract conceptualization, and active experimentation. This approach allows students to develop practical skills through hands-on experience, deepening their understanding of the material being taught (Butler, 2022; Murakami & Lehrer, 2022; O'Brien et al., 2021).

In the Mechanical Drawing course, implementing Experiential Learning methods can provide significant advantages. Students can learn to draw machines through authentic projects that require the application of theoretical concepts, helping them develop technical skills and analytical abilities more effectively (Benavente et al., 2020; Mc Pherson-Geyser et al., 2020). Previous studies have shown that experiential learning can increase student engagement and motivation and deepen their understanding of the subject matter (Benavente et al., 2020; Mc Pherson-Geyser et al., 2020).

In today's technological era, mechanical drawing skills should include software such as Computer-Aided Design (CAD) (Regassa Hunde & Debebe Woldeyohannes, 2022). CAD software allows students to create more detailed and high-quality designs. According to (Zhao, 2020), CAD is a necessary software that supports humans in designing specific designs with various supporting applications. Meanwhile, according to (Chaudhary et al., 2020), designers widely use CAD to produce high-quality drawings. Thus, using CAD can help mechanical engineering students improve their drawing skills. However, students often lack time to learn CAD in depth due to the focus on conventional tools. This creates a gap in their ability to draw details using modern software. Therefore, this study aims to apply the Experiential Learning method to improve students' understanding and skills in mechanical drawing with both conventional and CAD methods.

This study uses CAD methods to apply the Experiential Learning method to improve students' understanding and skills in drawing machines. The Experiential Learning method was chosen because of several problems in Mechanical Engineering Study Program students: lack of time to learn CAD, insufficient mechanical drawing skills, and limitations in drawing detailed machine components. The novelty of this research lies in the unique combination of the Experiential Learning method and the use of CAD in learning mechanical drawing, which has not been widely applied before. This integration offers a new learning model that effectively improves students' understanding and skills and is relevant to current industry demands, providing a practical solution for engineering education in Indonesia. The research questions in achieving the objectives of this research are:

RQ1. How can implementing the experiential learning methods in the Mechanical Drawing course improve students' understanding of mechanical drawing concepts and techniques?

RQ2. To what extent can the results of real projects using the experiential learning method improve students' practical skills in drawing machines?

This research contributes significantly to improving the quality of engineering education by implementing the experiential learning method in the mechanical drawing course. By integrating Computer-Aided Design (CAD) technology, this research

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introduces European projection-based mechanical drawing techniques and overcomes the shortcomings of conventional learning that uses manual tools. This approach enables students to acquire practical skills relevant to modern industries better to prepare them for the increasingly digitalized world of work. In addition, this research contributes to developing a more adaptive and technology-based curriculum, providing a basis for educational institutions to revise teaching materials to suit industry needs and technological developments better.

2. Methods

2.1 Research design

This research uses a quantitative design with statistical methods because the data is numerical and analyzed to obtain the required averages. According to (Mohajan, 2020), Quantitative research processes numerical data obtained from data collection and is described statistically. This research is quasi-experimental (Prasetya et al., 2023; Rahim et al., 2024). Using an experimental class and a control class, this method can identify differences in results between the treatment class and the control class (Miller et al., 2020).

Table 1. Quasi experiment research design

Class	Pre-test	Treatment	Post-test
Experimental class	O^1	X^1	O^2
Control class	O^2	X^2	O^4

This research design implemented the quasi-experimental method by using the experiential learning method for the experimental class and the conventional method for the control class. This study also included pre-tests and post-tests in both classes, with each group receiving five treatments. The pre-test was administered before the learning process began, while the post-test was administered after the learning process was completed.

2.2 Research subjects

The subjects of this research are first year students enrolled in technical drawing courses at the Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Padang. There were 60 students in the experimental class and 20 in the control class.

2.3 Treaments

2.3.1 Experiental learning method

In the experimental class, the learning cycle research consisted of four stages: Experiencing, Reflecting, Thinking, and Acting. This cycle is known as the Experiential Learning model developed by (A. Y. Kolb & Kolb, 2012). This model can be implemented engagingly and effectively. The stages of this learning are designed to provide students with a deep and comprehensive learning experience, as presented in Figure 1.

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Figure 1. The experiential learning cycle (A. Kolb, 2020)

Figure 1, particularly in the Experiencing stage, shows that students experience learning activities directly (A. Kolb, 2020). Mechanical drawing courses may involve real projects where students work with design software, drawing tools or machine prototypes. Students gain in-depth practical experience by interacting directly with the subject matter. After experiencing the learning activity, students move into the Reflecting stage, where they analyze what they have done, how they did it, and what the results were (Lynch et al., 2021). This stage can involve group discussions, writing reflection journals, or presentations on the learning they have gained over several meetings.

The next stage is Thinking, where students process information and learn from previous reflections (Chen et al., 2019). They consider ways to improve or apply the new knowledge gained. In the context of a mechanical drawing course, students might think about how the design principles they learn can be applied to other projects or how they can improve their designs based on feedback received. The final stage, Acting, involves implementing what they have learned (Schmidt & Tawfik, 2022). Students apply their knowledge and reflections to a new project or improve an existing project and may return to the Experiencing stage with a new project, creating a continuous learning cycle.

Implementing the experiential learning model in the mechanical drawing course through real projects provides a richer and more meaningful learning experience. Students understand the concepts of mechanical drawing theoretically and apply them practically, which ultimately improves their understanding. This model encourages active learning, where students participate directly in the learning process, which is proven to be more effective than passive learning. Thus, experiential learning can significantly improve students' understanding of mechanical drawing courses through engagement in real projects. Finally, the implemented Experiential Learning Method follows four steps in the learning process described in Table 2.

Table 2. Stages of experiential learning

No	Stage	Lecturer activities	Student activities
1	*Concrete Experience* (CE)	Lecturers facilitate students' full engagement in new experiences.	Students fully immerse themselves in the new experience.
2	Reflection Observation (RO)	Lecturers assist and guide students in making observations and reflecting or thinking about the experience from various aspects.	Students observe and reflect or think about the experience from various perspectives.
3	Thinking Conceptualization (TC)	Lecturers explain to students how to create concepts that integrate observations into theories.	Students create concepts that integrate their observations into the theory
4	Active Experimentation (AE)	Lecturers guide students to use theory to solve problems and make decisions based on experience.	Students use theory to solve problems and make decisions.

2.3.2 Conventional learning method

In this control class learning, students were not treated as much as the experimental class. Nevertheless, the students received conventional learning treatment and could choose the project tasks they wanted to work on based on their interests and abilities. This approach allows students to stay engaged and motivated in the learning process despite not going through the whole experiential learning cycle.

By providing a choice of projects, students in the control class can develop skills that are relevant and in line with their interests, which can increase their sense of ownership and responsibility for their learning. Although the intensity and depth of treatment in the control class differed from the experimental class, the flexibility in project selection allowed students to experience meaningful and contextualized learning.

2.4 Research instruments

The research instruments used in this study include Pre-test, Post-test, and performance assessment (González-Alonso et al., 2020). The pre-test is given before the treatment or teaching process begins to assess students' initial understanding of the upcoming material. The pre-test consists of 20 multiple-choice questions measuring students' initial knowledge. The post-test, on the other hand, was conducted after the completion of the teaching intervention. Its purpose was to measure students' understanding of detailed drawings in the cognitive domain after implementing the Experiential Learning method in the experimental group and the conventional teaching method in the control group. The post-test also consisted of multiple-choice questions that had been pilot-tested. The test questions for the pre-test and post-test refer to the learning outcomes of the Mechanical Drawing course

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set by the Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Padang (Table 3).

Table 3. References for test question creation

Learning outcomes	Criteria/Assessment indicator	The grid questions
CLO-4.1: [CP - 3.1] 1. Students can understand commands in CAD software. 2. Students can read and create European system projection drawings using the Solidworks application. 3. Differentiate between American and European system projection drawings-1	Understand the function of commands in CAD software to create and modify 3D CAD drawings.	1. Students can learn the Tollbar in Solidworks in making 3D drawings. 2. Students can correctly explain the commands in CAD software to create 3D CAD drawings, including Extrude, Revolve, Sweep, Loft, and Spiral. 3. Students can explain the function of the commands used.
CLO-4,2: [CP - 3.1] 1. Students can use CAD software. 2. Students can read and create American system projection drawings on Solidworks applications. 3. Differentiate between American and European system projection drawings - 2.	Use command functions in CAD software to create and modify 3D CAD drawings.	1. Given an image, learners can determine the order used/ 2. When presented with an image, learners can determine the order in which the image is made. 3. Learners can explain the function of the command used.
	Able to explain and illustrate American and European projection drawings in Solidworks application.	1. Students can know the types of projections 2. Students can explain the types of projections 3. Students can describe the projections

Performance assessment evaluates tasks students must complete within a specific time limit (Yan, 2020). This evaluation uses a performance assessment rubric to measure students' ability to draw details during practicum. This rubric focuses on the psychomotor aspect, evaluated by lecturers (observers) during the lecture or practicum process. Further details regarding the rubric for evaluating students' abilities can be seen in Table 3.

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Table 3. Rubric

Component/Subcomponent	Score			
	1	2	3	4
A. Competency Achievement Indicators				
A1. Competency Achievement Standard				
A2. Working Drawing				
B. Work Process				
B1. Use of Tools and Materials				
B2. Work Steps				
C. Work Result				
C1. Image Projection				
C2. Dimensions				
C3. Accuracy of Line Use				
D. Time				
D1. Timeliness of project completion				

2.5 Data collection technique

The data collection techniques used in this study include tests, performance assessments, and documentation. First, the test consisted of 20 multiple-choice questions given to students before (Pre-test) and after (Post-test) learning sessions in the experimental and control groups. Second, a performance assessment was conducted to evaluate the psychomotor aspects mastered by students. Third, documentation is done by collecting data from written sources, where researchers directly obtain existing documents such as a list of student names.

2.6 Data analysis technique

The normality test used the Shapiro-Wilk test to assess whether the research data followed a normal distribution (Sari et al., 2019). Statistical analysis was conducted using SPSS version 20.0, with a significance level set at 0.05. Second, the homogeneity test was used to determine whether the initial data conditions of the two samples were homogeneous in terms of data variance. This study used the Homogeneity of Variance test on One-way ANOVA through SPSS 20.0. Third, using the T-test, the hypothesis test aimed at evaluating the impact of the Experiential Learning method on the understanding of detailed drawings.

3. Results and discussion

3.1 Descriptive statistical analysis

The results of this research analysis observed the effect of experiential learning methods on students' understanding of learning Mechanical Drawing through authentic projects. The research briefly presents statistical data assessing the experimental and control groups, starting from the pre-test to the post-test, using 20 Multiple Choice type questions in Table 4.

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Table 4. Results of descriptive analysis of student knowledge of machine drawing

Type of Test	Group	N	Min.	Max.	Mean	SD
Pre-Test	Experiment	60	15	90	53	18.7
	Control	20	15	85	54	17.7
Post-Test	Experiment	60	40	100	74	15.6
	Control	20	35	90	65	14.6

At the pre-test stage, two groups were observed: the experimental group with 60 students and the control group with 20 students. The experimental group showed a range of scores from 15 to 90, with a mean of 53 and a standard deviation of 18.7. This pre-test data showed a relatively normal distribution of scores in the experimental group, with a Shapiro-Wilk p-value of 0.976 (>0.05). There was no significant difference in variance between the experimental and control groups, indicated by Levene's test p-value of 0.170 (> 0.05).

Table 5. Normality and homogeneity test of students knowlegde in mechanical drawing

Type of test	Group	Normality test		Homogeneity test	
		Shapiro-Wilk	Sig.	Levene's statistic	Sig.
Pre-Test	Experiment	0.976	0.277	0.170	0.681
	Control	0.978	0.901		
Post-Test	Experiment	0.968	0.113	0.255	0.615
	Control	0.973	0.816		

At the post-test stage, the experimental group showed significant improvements in student understanding after implementing the experiential learning method. The range of post-test scores for the experimental group was from 40 to 100, with a mean of 74 and a standard deviation of 15.6. The post-test data also showed a relatively normal distribution in the experimental group, with a Shapiro-Wilk p-value of 0.968 (>0.05). There was no significant difference in variance between the experimental and control groups for the post-test data, as indicated by Levene's test p-value of 0.255 (>0.05). The graph showing the results of the analysis of Experiential Learning Outcomes is presented in Figure 2.

Overall, these results indicate that implementing experiential learning methods in learning mechanical drawing through real projects can effectively improve students' understanding. The significant difference between pre-test and post-test scores in the experimental group indicates that this approach can potentially improve student learning outcomes in the context of practical experience on real projects in mechanical drawing learning. These results support the hypothesis that the experiential learning method can effectively improve engineering education quality, focusing on hands-on experience in actual project learning to improve students' understanding and skills.

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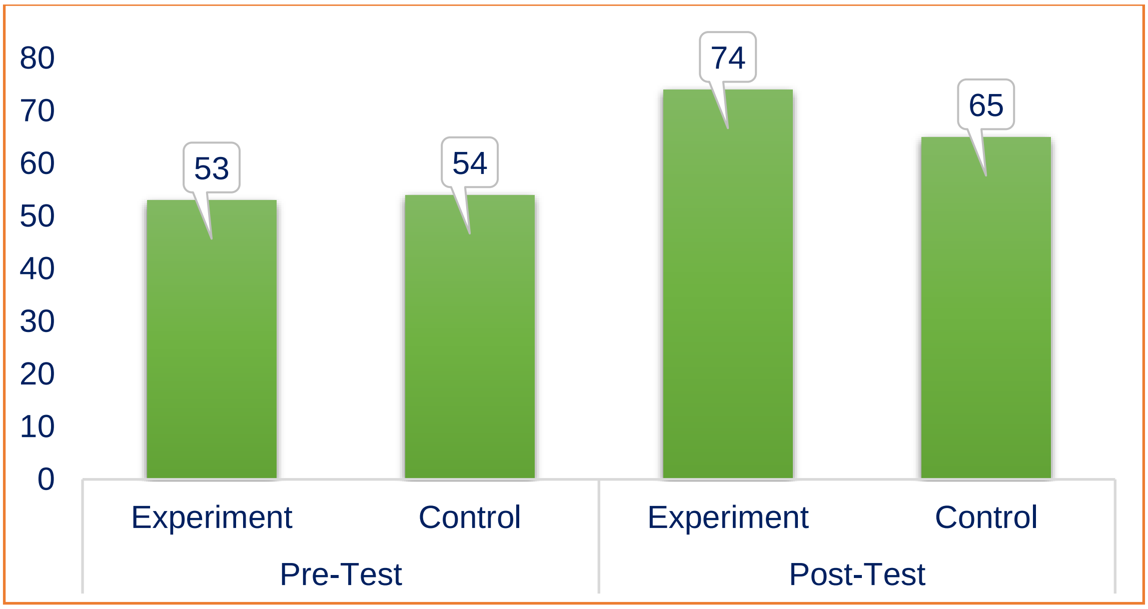

Figure 2. Comparison of students knowledge in mechanical drawing

3.2 Mechanical drawing skills

Based on the results of the skill scores (psychomotor) of experimental class students after treatment, it can be seen that the highest student score is presented in Table 6.

Table 6. Mechanical drawing skills

Group	N	Min.	Max.	Mean	SD
Experiment	60	53.1	96.9	76.6	12.2
Control	20	53.1	81.3	67.6	9.4

On the psychometric assessment, two groups were observed: the experimental group with 60 students and the control group with 20 students. The experimental group showed a range of scores from 53.1 to 96.9, with a mean of 76.6 and a standard deviation of 12.2. The distribution of scores in the experimental group showed a reasonably normal distribution with a Shapiro-Wilk p-value of 0.966 (>0.05), indicating that the data were not significantly different from a normal distribution. In addition, the homogeneity of variance test with Levene's test showed no significant difference in variance between the experimental and control groups, with a p-value of 1.289 (> 0.05).

Table 7. Results of assessment of students' machine drawing ability

Group	Normality Test		Homogeneity Test	
	Shapiro-Wilk	Sig.	Levene's Statistic	Sig.
Experiment	0.966	0.098	1.289	0.260
Control	0.925	0.125		

Meanwhile, the control group showed a range of scores from 53.1 to 81.3, with a mean of 67.6 and a standard deviation of 9.4. The distribution of scores in the control group also showed a relatively normal distribution with a Shapiro-Wilk p-value of 0.925

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(>0.05), which also indicated that the data was not significantly different from a normal distribution.

These results show that the experimental group using the experiential learning method had a higher average psychometer score (76.6) than the control group (67.6). This difference indicates that the experiential learning method applied to the mechanical drawing subject can significantly improve students' psychomotor skills compared to the conventional learning method. Thus, these results support the hypothesis that implementing the experiential learning method in the mechanical drawing course through real projects can improve students' understanding and psychomotor skills, significantly positively impacting students' learning outcomes.

3.3 Hyposhesis test analysis results

The research data show a normal and homogeneous distribution based on the normality and homogeneity tests. Therefore, the researcher tested hypothesis using a parametric statistical test, specifically the Independent Sample T-test. Details of this test can be seen in Table 8.

Table 8. Hypothesis test results of student post-test values on machine drawing knowledge skills

Class	N	$\bar{x}$	t_{count}	t_{table}	Sig-(2 Tailed)	Significance value
Experiment	60	74	2.2	1.671	0.026	0.05
Control	20	65				

Based on Tables 8 and 9, the cognitive achievement t-test results show significance at α = 0.05. Using the comparison of t-values > critical t-values, the cognitive achievement test result is 2.2 > 1.671, and the psychomotor drawing ability test result is 2.9 > 1.671. Alternatively, using the comparison of probability values (Sig 2-tailed) < significance level, the results are 0.026 < 0.05 for cognitive achievement and 0.004 < 0.05 for psychomotor drawing ability. Thus, the null hypothesis (Ho) is rejected, and the alternative hypothesis (Ha) is accepted. This result indicates a significant effect of the experiential learning method on the mechanical drawing course. The average post-test scores for the experimental class are 74.1, compared to 65 for the control class, and the average psychomotor scores for the experimental class are 76.6, compared to 67.6 for the control class. This demonstrates a difference in mechanical drawing ability between the experiential and conventional learning methods. The percentage difference in learning outcomes is as follows: detail drawing understanding (cognitive) shows a percentage of 13.96%, and drawing ability (psychomotor) shows a percentage of 13.31%.

Table 9. Hypothesis test results of drawing skills values of control class students and experimental classes

Class	N	$\bar{x}$	t_{count}	t_{table}	Sig-(2 Tailed)	Significance value
Experiment	60	76.6	2.9	1.671	0.004	0.05
Control	20	67.6				

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Based on the research data presented in Tables 8 and 9, the analysis conducted by the researcher further describes the research data. After conducting the study, the data must be analyzed to measure normality, homogeneity, and research hypotheses. If the data are normally distributed and the groups are homogeneous, then for the cognitive domain, t-value = 2.2 and critical t-value = 1.671, and for the psychomotor domain, t-value = 2.9 and critical t-value = 1.671, with a confidence level of 95% or significance level $\alpha = 0.05$. Since the t-value is greater than the critical t-value, the null hypothesis (Ho) is rejected, and the alternative hypothesis (Ha) is accepted. This indicates a significant effect of the experiential learning method on mechanical drawing ability in the cognitive and psychomotor domains in the Mechanical Drawing course for the 2024/2025 academic year. This is evident from the average post-test scores of the experimental class, which are 74.08 for cognitive and 76.6 for psychomotor, compared to the control class's average scores of 65 and 67.6, respectively. The data show that the average learning outcomes for cognitive and psychomotor abilities in the experimental class using the experiential learning method are higher than in the control class using the conventional model.

3.4 Student Works by Class and Assignment Given

Each class was given a different task, where the experimental class was asked to draw details of tool or machine components in the form of a project, while the control class was asked to draw details of parts that could be combined into one tool. The following are examples of student work from the experimental and control classes and their application models.

3.4.1 Experiment class (Experiental Learning)

Student 1

Student 1 designed a 3-bladed Wind Turbine and an Archimedes Wind Turbine to generate electricity with high efficiency. These turbines use the aerodynamic force of the blades, similar to aeroplane wings or helicopter propellers, to convert wind energy into mechanical energy and then electricity. This design can be implemented in areas with variable wind speeds, increasing the sustainability and efficiency of renewable energy. The resulting design is shown in Figure 3.

(a) (b) (c)

Figure 3. (a) Coastal area of Padang city (b) Wind turbine design model 3 blades (c) Archimedes wind turbine design

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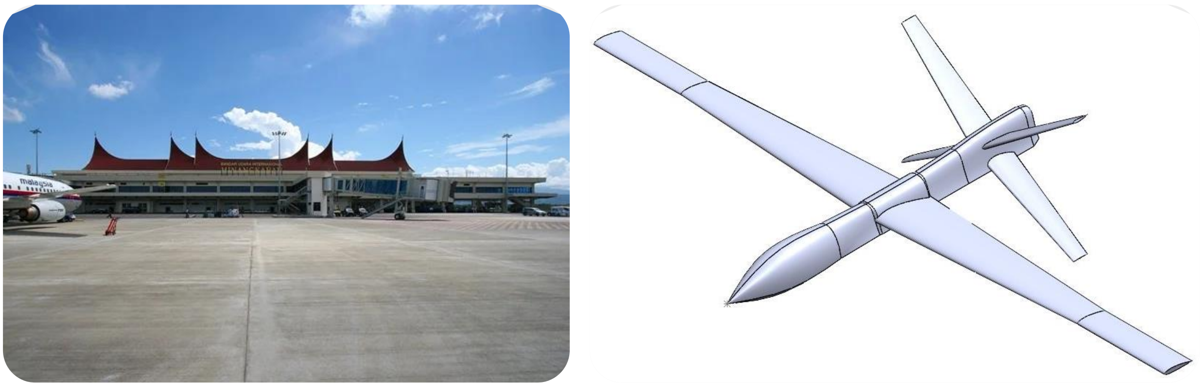
Student 2

Student 2 designed an Unmanned Aircraft flown over Minangkabau International to monitor environmental conditions and conduct aerial surveys in the West Sumatra region. The aircraft is equipped with advanced sensors and high-resolution cameras to collect environmental change, agriculture, and natural disaster monitoring data. With an efficient aerodynamic design, the aircraft can fly for a long duration and cover a large area, making it very useful for natural resource monitoring and management. Implementing this technology is expected to increase the effectiveness of data collection and provide accurate and real-time information for related parties. The results of this design are presented in Figure 4.

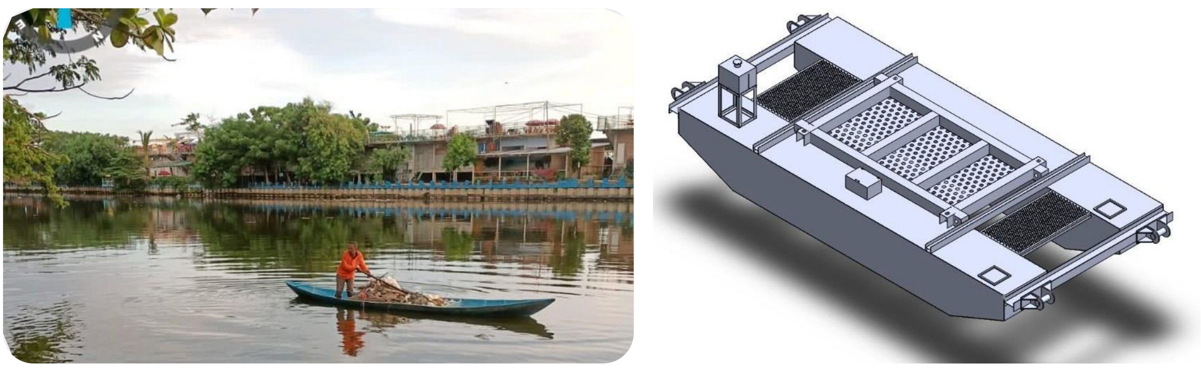


(a) (b)

Figure 4. (a) Minangkabau International Airport (b) Unmanned aircraft design

Student 3

Student 3 designed a floating machine that cleans the water surface of trash and pollutants. The machine has an automated filtration and collection system to capture and transport plastic waste, oil, and other debris from the water surface to a holding container. With an efficient and eco-friendly design, the floating machine is designed to operate in lakes, rivers, and harbours, helping to keep aquatic ecosystems clean and healthy. Implementing this technology is expected to contribute to water pollution control efforts and support sustainable environmental hygiene programs. The results of this design are presented in Figure 5.



(a) (b)

Figure 5. (a) Cimpago Lake Padang city (b) Floating mechanical design

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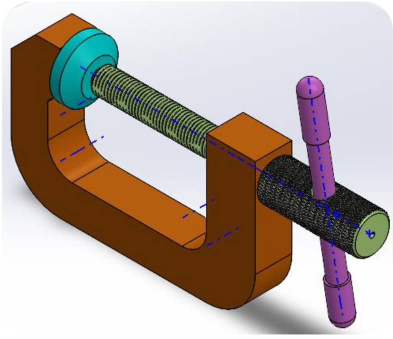
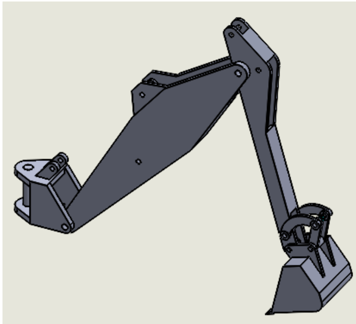
3.4.2 Control class

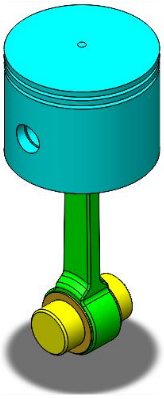
Students in the control class selected one of four predefined component designs to implement in their final project. Each design offers a different technical solution and is intended for specific applications, such as a locking component (Klem C), a material handling tool (Excavator Arm), an engine combustion system component (Piston Kit), and a two-bar corner connector (Knuckle Joint). After choosing the most suitable design, students must develop and modify it further, ensuring it meets operational needs and existing industry standards. The project's final outcome will be evaluated based on the effectiveness, efficiency, and innovation in implementing the chosen design. The results of this design will be presented in the final report and illustrated in Figure 6.



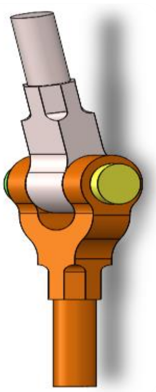
(a)



(a)



(c)



(d)

Figure 6. (a) Component design of clamps C; (b) Component design of excavator arm; (c) Component design of seher piston kits; (d) Component design of knuckle joint

Briefly, students in the control class only received conventional learning without the freedom to choose projects as in the experimental class. They were given the opportunity to choose one of the four projects provided by the lecturer. Conversely, in the experimental class, students can design their own projects based on their experiences and apply them to the real world, especially in developing regional potential. This approach allows students to not only learn theory but also apply it practically, so that they can identify and utilize local resources to improve sustainability

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and innovation in their environment. Additionally, this approach encourages creativity and problem-solving skills that suit the specific needs and potential of each student's region.

3.5 Discussion

This study shows that implementing experiential learning methods in the Mechanical Drawing course can significantly improve students' understanding and skills compared to conventional learning methods. Through statistical analysis, it was found that the average value of the post-test in the experimental group was higher than the control group. This shows that the experiential learning method that actively involves students in authentic projects can significantly positively impact the understanding and skills of drawing machines.

The integration of the use of Computer-Aided Design (CAD) software in the experiential learning method also showed positive results (Dhabliya et al., 2023; Hunde & Woldeyohannes, 2022; Wang et al., 2023). Students who use CAD software in the learning process can produce more detailed and high-quality drawings. This is consistent with previous studies' findings, which show that using technology in learning can improve student learning outcomes (Fakhry et al., 2021; Fraile-Fernández et al., 2021). Thus, combining the experiential learning method with CAD can be considered an effective strategy for improving students' technical skills.

This study supports previous research results, which state that experiential learning can increase students' engagement, motivation, and understanding of the subject matter (Motta & Galina, 2023). This research also aligns with the findings of (Syahril et al., 2020, 2022, 2021), which emphasizes the importance of understanding and implementing mechanical drawing skills in mechanical engineering education. However, this research offers a new contribution by combining experiential learning methods and CAD software, which has not been widely applied. This combination provides a new learning model relevant to current industry demands and a practical solution for engineering education in Indonesia.

In order to ensure the validity and reliability of the research results, the researcher used several triangulation techniques, namely method triangulation, data triangulation, and theory triangulation (Dzwigol, 2022; Santos et al., 2020). Method triangulation uses data collection techniques such as pre-test, post-test, and performance assessment. Data triangulation was conducted by comparing data from various sources, including primary data from tests and secondary data from documentation. Theoretical triangulation was conducted by comparing this study's results with previous research findings and relevant theories, such as experiential learning theory from the National Science Foundation (Bergsteiner et al., 2010).

4. Conclusion

This study shows that implementing the Experiential Learning method in the Mechanical Drawing course significantly improves students' understanding and skills in mechanical drawing, both with conventional methods and Computer Aided Design (CAD) software. The Experiential Learning method, with its hands-on, experience-based approach, showed superiority over conventional learning methods in terms of

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improving students' technical skills and conceptual understanding. The results showed a significant difference between the experimental group's pre-test and post-test scores, indicating this method's effectiveness in improving students' cognitive understanding. In addition, significant improvement was also seen in the psychomotor skills of students who learned through Experiential Learning, evidenced by improved performance scores in mechanical detail drawing. This study implies that this approach can be an effective learning model to address challenges in engineering education, particularly in preparing students for the increasingly digital and complex demands of industry.

In future work, this research can be extended by exploring the long-term impact of the Experiential Learning method on students' work readiness in the mechanical engineering industry and testing its applicability in other engineering courses. In addition, further research can be conducted to evaluate the effectiveness of the Experiential Learning method in the context of distance or hybrid learning, as well as the integration of the latest technologies, such as virtual simulation, to support a more interactive and adaptive learning process.

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Declarations

Author contribution

Ridhollah Nasution: Writing – review & editing, Writing – original draft, Conceptualization, Data curation, Methodology, Visualization, Sofware. Arwizet K: Writing – review & editing, Formal analysis, Methodology, Supervision. Yolli Fernanda: Writing – review & editing, Supervision, Resources, Validation, Visualization.

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Competing interest

The authors declare no conflict of interest in this study.

Ethical Clerance

This research has obtained permission from the Faculty of Engineering, Padang State University with letter number 0738/UN.35.2.1/LT/2024 and the Mechanical Engineering undergraduate students involved have given their consent to become research subjects. This research was conducted according to the Declaration of Helsinki.

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