The Implementation of Project-Based Learning (PjBL) To Improve Learning Outcomes in Manufacturing Technical Drawing

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ABSTRACT

This study aims to: (1) analyze the implementation of the Project Based Learning (PjBL) model in improving students' learning outcomes in the subject of Manufacturing Technical Drawing in Grade XI of vocational high school; (2) analyze the improvement of student competencies in the subject through the application of the Project Based Learning model; and (3) analyze the increase in student activity, engagement, and participation during project-based learning.This research employed a Classroom Action Research (CAR) method.The research subjects were 33 students from Class XI TP 2 at SMK Negeri 2 Yogyakarta who had experienced learning through the Project-Based Learning model. Cognitive learning outcomes data were obtained through multiple-choice tests, while skills data were collected using observation sheets assessing students' practical performance. Data analysis was conducted using both quantitative and qualitative approaches.The results showed that: (1) the PjBL model was effective in improving students' learning outcomes, as evidenced by the increase in the average score from 74.09 in the pre-cycle to 77.52 in the third cycle, and the improvement in learning mastery from 55% to 91%. (2) Student competencies improved gradually, in terms of conceptual understanding, project completion, and contextual application of knowledge. (3) This model also succeeded in enhancing student activity and engagement, as indicated by the increase in average activity scores from 74.09 and engagement level of 55% in the pre-cycle to 77.52 and 91% in the third cycle. Students became more active, responsible, and positively involved in the learning process.

Keywords: Manufacturing Technical Drawing, Project-Based Learning, Student Learning Outcomes

INTRODUCTION

National Education System Law Number 20 of 2003 states that education is a learning process aimed at improving students' intelligence, confidence, and abilities. Quality education is crucial for developing a superior generation capable of competing in the workforce (Ambiyar et al., 2020). As a pillar of national progress, education plays a role in developing competent human resources that are adaptable to developments in science and technology. Vocational High Schools (SMK) are a national educational institution that must prioritize preparing students to choose careers, enter the workforce, acquire skills, and develop successfully in rapidly evolving fields that enable them to work in those fields. One of the qualities of SMK graduates is the ability to improve their work processes and manage their lives. SMK play a crucial role in national development, particularly in preparing a skilled and educated workforce needed by industry.

However, several studies indicate that learning in vocational schools, particularly in technical subjects such as Manufacturing Technical Drawing, is still dominated by teacher-centered instructional methods (Rahmawati, 2021; Nuraini & Hardinata, 2022). This approach often limits student engagement and reduces opportunities for students to develop problem-solving, visualization, and technical competencies. Engineering drawing, which requires precision, spatial visualization, and adherence to industry standards, demands active learning strategies that allow students to apply concepts through practice (Romadin et al., 2021).

Project-Based Learning (PjBL) has been widely recognized as an effective student-centered learning model that promotes active participation, collaboration, and contextual problem-solving (Bell, 2010; Krajcik & Blumenfeld, 2021). Previous studies have shown that PjBL can improve learning outcomes, creativity, and vocational competencies (Sari & Budiyanto, 2022). Nevertheless, many existing studies focus on general vocational subjects, while empirical evidence on the implementation of PjBL specifically in Manufacturing Technical Drawing—particularly using CAD-based projects—remains limited.

Student-Centered Learning (PjBL) is a student-focused learning model that enables students to gain a deeper understanding and actively participate in addressing real-world problems. In this model, students generate ideas for final assignments and solve real-world problems. This method can be used for specific student groups. Students engage in learning activities differently because their roles are not comprehensive. Students who passively participate in the learning process, simply receiving knowledge from the instructor, are less successful.

Comprehensive Project-Based Learning (PjBL) evaluation assesses the attitudes, knowledge, and skills acquired by students throughout their studies. Project assessment is the process of assessing the amount of work to be completed within a specified timeframe. Project work includes planning, collecting, organizing, processing, and disseminating information (Surya et al., 2018). Project evaluation can be used to assess students' understanding, practical skills, investigative skills, and information-sharing abilities. Every form of learning has its advantages and disadvantages. Project-Based Learning (PjBL) helps students solve problems while participating in project activities. This project work also provides students with hands-on experience in project planning. In the future, such experiences can help students improve their learning outcomes and become more creative. The project-based learning (PjBL) model can improve student learning outcomes. This is crucial in producing vocational high school graduates who excel not only in technical skills but also possess soft skills such as communication, leadership, and time management. Drawing is a visual medium used to depict objects or ideas in two-dimensional (2D) forms, such as slides, paintings, films, opaque projections, or lines (Hamalik, 2017). Therefore, an optimal learning process is needed, one that not only emphasizes the delivery of material but also encourages student activeness so they can develop professional technical visualization skills (Romadin et al., 2021).

The main problem in student competency mastery in the Manufacturing Engineering Drawing subject at SMK Negeri 2 Yogyakarta lies in their low ability to understand basic engineering drawing concepts and apply them to real-world practice. Many students still struggle to read, interpret, and draw engineering drawings according to industry standards, both manually and using software like AutoCAD. Visualization and precision skills, key to engineering drawing, are also still suboptimal. Furthermore, students tend to be passive in the learning process because the method used is still predominantly lecture-based and not project-based or hands-on. Facilities are limited, such as the relatively new learning software, meaning students have never used AutoCAD before. As a result, student competency achievement is uneven, with many still lacking.

METODE

Classroom Action Research (CAR) or Classroom Action Research was used in this study. The purpose of this study was to improve student learning outcomes in the subject of Manufacturing Engineering Drawing by using a project-based learning model. This model was chosen because this model can help teachers improve the learning process directly by carrying out systematic, planned, and reflective actions. The subjects in this study were 33 students of class XII of Machining Engineering at SMK Negeri 2 Yogyakarta who participated in Manufacturing Engineering Drawing learning. Data collection in this study was carried out using test, observation, documentation, and interview techniques. Criteria for Action Success The success of the action in this study was determined based on three main criteria as follows: Cognitive: At least 85% of students obtained a score of ≥ 75 on the learning outcome test, Affective: At least 80% of students showed high learning activity during the learning process based on observation and Psychomotor: At least 85% of students were able to complete the manufacturing engineering drawing project. Data analysis techniques in this study were used to process and understand the qualitative and quantitative data obtained during the classroom action. Quantitative data were obtained from student learning test results in each cycle, which were analyzed to

determine student learning outcomes from pre-cycle73 to cycle III. These test results were analyzed by calculating the average student score and the percentage of students achieving the minimum completion criteria (KKM), which indicates student learning outcomes.

The research instruments used were multiple-choice questions to measure knowledge learning achievement and observation sheets to measure students' learning skills in manufacturing engineering drawings. The instruments were then tested for validity and reliability to ensure consistency in measuring student learning achievement. The results of the validity and reliability tests on 20 multiple-choice questions showed that 19 were valid and reliable. Collaborative and participatory classroom action research is a type of research conducted collaboratively and involves the participation of various parties. Ethical considerations were addressed by obtaining permission from the school, informing students about the research objectives, and ensuring confidentiality of student data. Participation in the study did not affect students' academic evaluation outside the research context.

RESULT AND DISCUSSION

The results indicate a consistent improvement in student learning outcomes, competencies, and learning engagement across the research cycles. In the pre-cycle phase, the average student score was 74.09, with only 55% of students achieving learning mastery. Following the implementation of PjBL, student performance improved progressively, reaching an average score of 77.52 and a mastery level of 91% in the third cycle.

Result

This pre-cycle activity is conducted before the class begins to provide an initial understanding of the learning process and the level of student activity as well as the results of drawing exercises using CAD software. At this stage, the researcher aims to measure student learning outcomes before the cycle. The following are student learning outcomes after the pre-cycle activity. Data obtained from the documentation of teacher assessments of student work is used as a basis for determining the next steps in the cycle.

Observation Stage

Student activity and engagement also demonstrated a positive trend. Observation data revealed a shift from moderate participation in the pre-cycle phase to high levels of active involvement in group discussions, project execution, and problem-solving activities by the third cycle. Competency questionnaire results further confirmed improvements in students' technical drawing skills, project completion abilities, and confidence in applying knowledge contextually.

Table 1 Data Distribution of Observation Stage at Pre-Cycle, Cycle 1, Cycle 2, and Cycle

Description	Pre-Cycle	Cycle 1	Cycle 2	Cycle 3
Total Actual Score	27	31	45	55
Total Ideal Score	60	60	60	60
Percetage	0,45%	0,51%	0,75%	91,66%
Category	Fair	Fair	Good	Good

Competency Questionnaire

At this stage, the researcher's goal was to determine whether students' abilities in pre-cycle activities correlated with learning outcomes. The questionnaire results indicated the students' competency levels in pre-cycle activities as follows:

Table 2 Data Distribution of Competency Questionnaire at Pre-Cycle, Cycle 1, Cycle 2, and Cycle

Category	Pre-Cycle	Cycle 1	Cycle 2	Cycle 3
Very good	0%	45%	35%	90%
Good	10%	80%	80	75%
Adequate	85%	40%	35%	0%
Poor	55%	0%	5%	0%
Very Poor	15%	0%	5%	0%

Student Learning Qutcomes

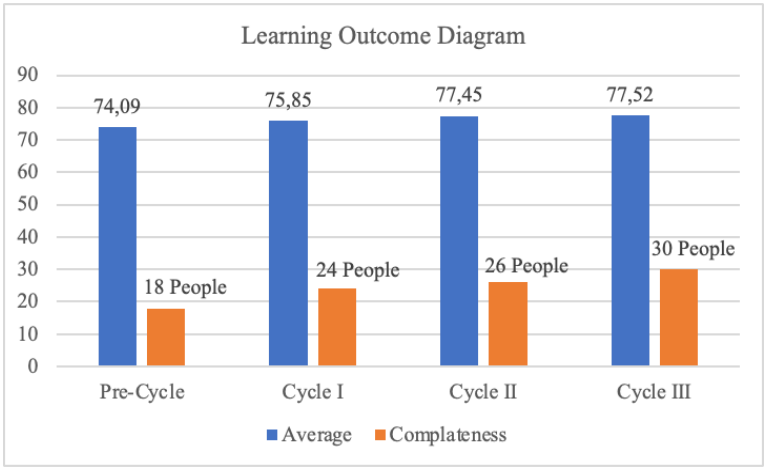
At this stage, the researcher aimed to measure student learning outcomes pre-cycle. The following are student learning outcomes after pre-cycle activities:

Table 3 Data Distribution of Student Learning Qutcomesat at Pre-Cycle, Cycle 1, Cycle 2, and Cycle

Precetage	Pre-Cycle	Cycle 1	Cycle 2	Cycle 3
Hightest Score	78	79	81	84
Lowest Score	68	73	71	73
Average Score	74,09	75,85	77,45	77,52
Number of Students Complated	18	24	26	30
Precetage of Learning Completion	55%	73%	79%	91%

DISCUSSION

The discussion of the results of this study focuses on improving student learning outcomes and student achievement in the CAD learning process. In learning activities, an atmosphere that encourages students to play an active role in the learning process is essential.



The findings of this study support previous research indicating that Project-Based Learning enhances student learning outcomes and engagement in vocational education (Bell, 2010; Markham et al., 2021). The

improvement in student performance can be attributed to the active learning environment created through project-based tasks, which encourage students to apply theoretical concepts to real-world technical problems.Compared to traditional lecture-based methods, PjBL provides opportunities for collaborative learning, hands-on practice, and reflective thinking. These elements are particularly important in Manufacturing Technical Drawing, where spatial visualization, accuracy, and procedural skills are essential. The gradual improvement observed across cycles suggests that repeated exposure to project-based activities strengthens both cognitive understanding and psychomotor skills. This study aligns with Sari and Budiyanto (2022), who found that PjBL improves technical drawing competencies in vocational schools. However, this research extends previous findings by demonstrating the effectiveness of PjBL in CAD-based manufacturing drawing contexts, thereby contributing empirical evidence to a relatively underexplored area. The implementation of Project-Based Learning to Improve Learning Outcomes in Manufacturing Engineering Drawing in grade XI students at SMK Negeri 2 Yogyakarta resulted in improved student learning outcomes through projects, students mastering skills, and developing abilities by solving problems that are crucial for the manufacturing engineering drawing subject. The learning model in vocational schools can be increasingly effective and relevant to the learning needs of vocational schools. With the explanation of the data above, it can be concluded that the implementation of project-based learning to increase their activeness in the learning process and improve student learning outcomes shows that the project-based learning model in learning to improve learning outcomes in Manufacturing Engineering Drawing with an increase of at least 75% of students to obtain a score of ≥ 76.00.

CONCLUSIONS

Based on the research results and discussions outlined in the previous chapter, the following conclusions can be drawn:

1. The Project-Based Learning (PjBL) model has been proven to improve student learning outcomes in Manufacturing Engineering Drawing in 11th-grade vocational high schools. This improvement is evident in the continuous improvement in student grades in each cycle. In the pre-cycle phase, the average student grade was 74.09, with a completion rate of 55%. After implementing the PjBL model, the average grade increased to 75.85 in Cycle I, 77.45 in Cycle II, and 77.52 in Cycle III. The learning completion rate also increased from 55% in the pre-cycle phase to 91% in Cycle III.

2. The implementation of the Project-Based Learning (PjBL) model can improve student competency in Manufacturing Engineering Drawing. This improvement is evident in the gradual increase in students' average scores, from 74.09 in the pre-cycle to 75.85 in Cycle I (a 2.38% increase), then to 77.45 in Cycle II (a 2.11% increase), and finally to 77.52 in Cycle III (a 0.09% increase). These results indicate that student competencies, particularly in understanding the material, completing project assignments, and applying knowledge to real-world contexts, have improved through the Project-Based Learning (PjBL) model.

3. The Project-Based Learning (PjBL) model is able to increase student activity, engagement, and involvement in learning Manufacturing Engineering Drawing. In the pre-cycle phase, students' average activity score only reached 74.09, with an active participation rate of 55%, indicating low student participation. After implementing the PjBL model, students' activity and engagement scores increased significantly in each cycle, reaching an average activity score of 77.52 and an engagement rate of 91% in cycle three. This improvement indicates that students are increasingly active, responsible, and positively engaged in learning, both individually and in groups. The classroom atmosphere becomes more dynamic, interactive, and collaborative, as students become accustomed to discussions, exchanging ideas, and completing projects on time.

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