Development of Jobsheet Based on Collaborative Project Based Learning in Lathe Machining Engineering Subjects

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Abstract: Effective practical learning in vocational education requires instructional tools that support collaboration and contextual problem-solving. Jobsheets integrated with Collaborative Project-Based Learning (CPjBL) are expected to address this need in Lathe Machining subjects. This study employed a modified 4D development model (Define, Design, Develop, Disseminate) to create a CPjBL-based jobsheet. The research involved 11th-grade Machining Engineering students at SMK Negeri 5 Padang, selected via purposive sampling. Data collection instruments included expert validation sheets, student questionnaires, observation checklists, and pretest-posttest assessments. The jobsheet featured collaborative tasks such as producing lathed components, with defined roles and peer coordination. Validation scores indicated strong content and design quality: material experts (92%), media experts (87%), and teachers (95%). Practicality was rated highly by both teachers (92.33%) and students (84.67%). The effectiveness test showed a significant learning gain with an N-Gain score of 0.65 (high category). Observations revealed active student collaboration through defined group roles, communication, and joint accountability. The CPjBL-based jobsheet effectively enhanced student engagement and machining competencies. Its integration into vocational learning aligns educational practices with industrial expectations and supports the development of collaborative, work-ready graduates.

Keywords: CPjBL; Jobsheet; Lathe maching; Vocational learning

Introduction

Vocational education plays a strategic role in developing a skilled workforce, particularly through the provision of high-quality practical learning that aligns with industry demands (Prasetya et al., 2021; Putri & Prasetyaningtyas, 2025; Wijaya et al., 2023). Vocational High Schools (SMKs) are expected to bridge the gap between education and the labor market (Baligar et al., 2022; Qizi, 2020). However, according to Indonesia's Central Statistics Agency (BPS) in 2022, SMK graduates had the highest unemployment rate among all educational levels, indicating a mismatch between learning processes and workplace requirements

Observations and interviews conducted with three teachers and twenty students at SMK Negeri 5 Padang revealed that the Lathe Machining subject relied primarily on technical drawings without accompanying jobsheets. Among seven practical subjects, five lacked any structured learning media. A teacher explained, "Students struggle to understand the machining sequence due to the absence of clear written instructions." Consequently, students became passive, requiring teachers to repeat explanations multiple times, leading to inefficiency and reduced learning quality (Adi et al., 2025; Apriana et al., 2025; Ellianawati et al., 2023).

Jobsheets have strong potential to enhance practical learning by offering structured guidance, including learning objectives, procedural steps, required tools and materials, and spaces for student self-assessment . In the context of Lathe Machining, jobsheets can aid students in mastering machining steps independently while increasing their engagement (Balu et al., 2024; Efendi et al., 2025; Enawaty et al., 2025). However, traditional jobsheets focus mainly on technical instructions and lack features that foster 21st-century skills such as teamwork, communication, and problem-solving. Therefore, an innovation is needed jobsheets that are not only procedural but also incorporate active, collaborative learning strategies. The Collaborative Project-Based Learning (CPjBL) model offers such an approach by emphasizing teamwork, real-world problem solving, and the creation of tangible project-based product (Ismathulhuda et al., 2022; Khairunnisa et al., 2025).

The integration of CPjBL into jobsheet design involves structured mechanisms such as group-based tasks, role assignments, and collaborative assessments. In this study, students are divided into heterogeneous teams to complete machining projects (e.g., producing shafts or bolts on a lathe machine) (Nidhom et al., 2022; Risqiyono et al., 2025; Sahjat et al., 2025; Setyawan et al., 2024). Each team member takes on specific roles such as operator, measurer, or safety officer—clearly outlined in the jobsheet. Assessment includes project rubrics, team reflection sheets, and group presentations. This approach transforms the jobsheet from a passive guide into a dynamic learning medium that mirrors real industrial collaboration, distinguishing it significantly from conventional, individual-centered jobsheets (Suyitno et al., 2022; Yerizon. et al., 2022).

The novelty of this research lies in the systematic integration of CPjBL principles into the content and structure of machining practice jobsheets. Unlike standard jobsheets, the developed version includes problem-based project scenarios, team role instructions, collaborative assessment rubrics, and individual reflection tasks (Sudjimat et al., 2021; Yoto et al., 2024). While prior studies focused on procedural guidance, this study emphasizes both technical and collaborative competencies within one medium . The product was developed using a modified Borg & Gall R&D model to ensure contextual relevance for vocational education settings (Rozan et al., 2024). Accordingly, this study aims to develop a CPjBL-based jobsheet that is valid, practical, and effective for Lathe Machining learning in vocational schools. Beyond a media product, the jobsheet is expected to increase student engagement, improve learning outcomes, and better prepare SMK graduates with the collaborative skills and industry-aligned competencies essential for the modern workforce (Fiqri et al., 2024; Paryanto et al., 2024).

Method

This study employed a Research and Development (R&D) approach using a modified 4D model: Define, Design, Develop, and Disseminate (Damayanti et al., 2022; Nirmayani et al., 2021). The modification lies in the integration of Collaborative Project-Based Learning (CPjBL) principles throughout the jobsheet development process (Qizi, 2020). The model refers to the general structure proposed by Thiagarajan et al., with adaptations for vocational learning contexts as cited by Putri et al. (2025), not a complete structural modification (Bulkini et al., 2023; Habibah, 2024; Samsiadi et al., 2022). The research focused on developing a CPjBL-based jobsheet for the Lathe Machining subject at SMK Negeri 5 Padang.

This development process is organized systematically and sequentially according to the 4D stages. To clarify the flow of development activities, the following flowchart is presented which describes the steps in this research process.
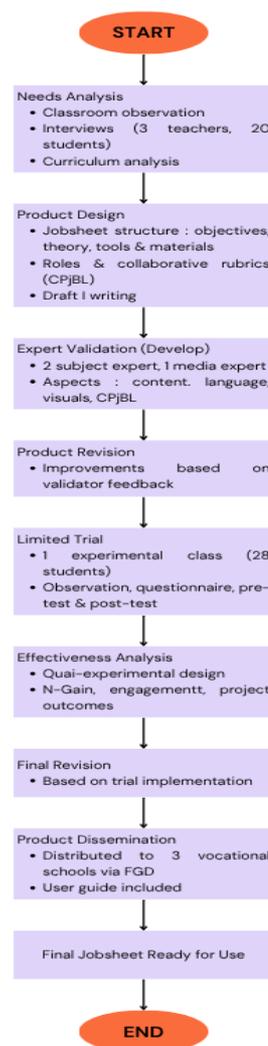

Figure 1. Jobsheet development flowchart

The flowchart above illustrates the systematic stages in the Collaborative Project Based Learning (CPjBL) based jobsheet development process used in the development research. Each stage has an important role in ensuring that the final product (jobsheet) is truly suitable for use in a vocational learning environment. The following is an explanation of each stage:

Define Stage

In the Define phase, needs analysis was conducted through classroom observation, curriculum document review, and semi-structured interviews with three vocational teachers and twenty students. Observations focused on existing learning practices, media limitations, and student engagement. Interview questions addressed instructional challenges and student difficulties in understanding machining sequences. Curriculum analysis reviewed core competencies (KI/KD), learning objectives, and practical learning standards relevant to Lathe Machining (Poetro et al., 2024; Pontjowulan, 2023).

Design Stage

Design phase involved drafting the initial structure of the jobsheet. The content framework included sections on learning objectives, brief theoretical background, tools and materials, work safety, procedural steps, individual reflection prompts, and collaborative rubrics. CPjBL elements were embedded by incorporating project tasks, group role assignments, and evaluation criteria for both group output and individual contribution. Format selection was based on clarity, visual support, and student usability, followed by writing the first draft (Draft I) of the jobsheet (Meilani et al., 2024; Verdian et al., 2024).
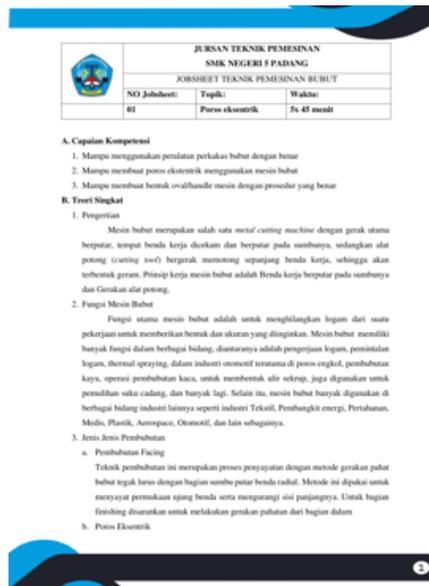

Figure 2. Title of jobsheet

Figure 3. Competency outcomes
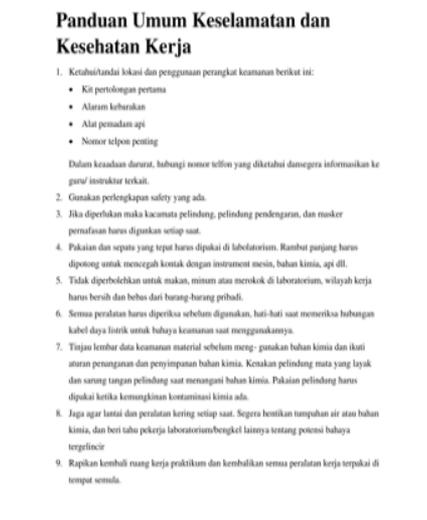

Figure 4. Tools and materials

Figure 5. Safety
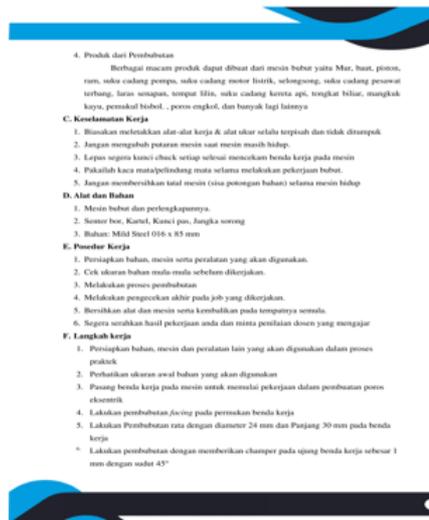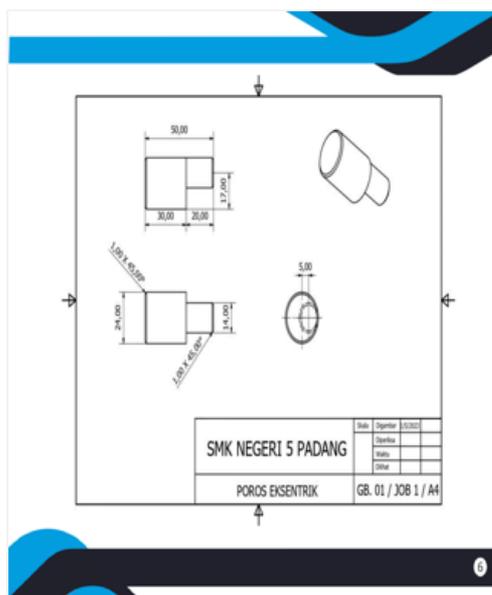

Figure 6. Work steps

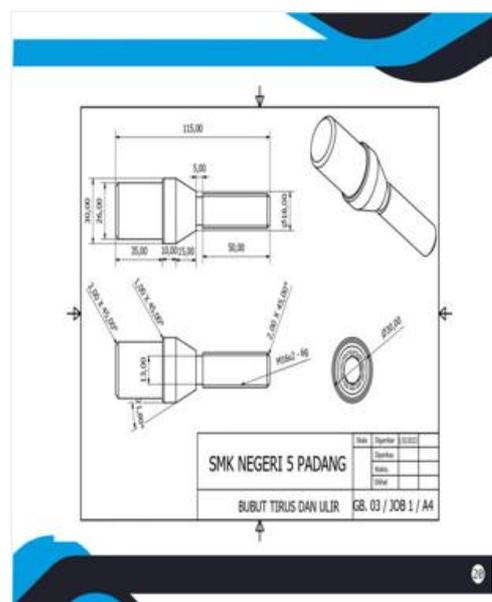**Figure 7.** Visualization of work process

Figure 8. Collaboration in projects

Develop Stage

In this phase, validation was conducted by two experts in machining (material experts) and one instructional media designer (media expert), with backgrounds in vocational education and educational technology. Validation instruments used Likert scales to assess content clarity, visual quality, language, and CPjBL integration. After revisions, a limited trial was conducted with 28 students in one experimental class. Instruments used included implementation observation checklists, student response questionnaires, and pre-test/post-test items. Effectiveness was measured using a quasi-experimental design with a control class (n=27) using conventional instruction. The N-Gain score was used to analyze learning improvement (Rahman et al., 2024; Saputra et al., 2024; Suparmi et al., 2024).

Disseminate Stage

The final stage involved dissemination of the revised product. The CPjBL-based jobsheet was distributed to three vocational schools through teacher focus group discussions (FGDs). No formal training was conducted, but user guides were included. Feedback from these schools was documented for potential future refinement (Falah et al., 2024; Igharo et al., 2024).

Clarification on CPjBL

CPjBL is not a separate phase but a guiding instructional model that underpins the entire development process—from task structuring to evaluation components. Hence, any mention of CPjBL as a standalone step in visual diagrams should be interpreted as the philosophical foundation embedded throughout each phase (Fontes Neto et al., 2022; Hing Lie et al., 2023).

Experimental Design

This study used a quasi-experimental design with a non-equivalent control group. Both experimental and control groups received pre-tests and post-tests, but only the experimental group used the CPjBL-based jobsheet. Effectiveness was assessed through cognitive learning outcomes (test scores), behavioral engagement (observation), and product quality (rubric-based assessment) (Budi et al., 2024; Lestari et al., 2024).

This flowchart shows that the development of learning media is not just designing materials, but a continuous process involving needs analysis, scientific validation, improvement, and field effectiveness testing. The result is learning media that is relevant, applicable, and contextual in accordance with the demands of 21st century education (Putra et al., 2025).

Results and Discussion

Identification of Problems and Rationale for Development

The development of the Collaborative Project Based Learning (CPjBL) jobsheet began with identifying critical learning challenges in the Lathe Machining practices at SMK Negeri 5 Padang. Observations and interviews with teachers and students revealed that practical activities were not supported by structured learning media. Students found it difficult to follow machining steps independently, while teachers often had to repeat instructions, resulting in time inefficiency and reduced learning quality. This situation underscored the need for a learning medium that promotes active engagement, structured practice, and alignment with industrial work expectations.

CPjBL Jobsheet Design and Integration

To address these challenges, a CPjBL-based jobsheet was developed with key components: learning objectives, brief theoretical background, tools and materials list, safety instructions, detailed work steps, collaborative assessment rubrics, and individual reflection sections. The CPjBL model was embedded through the following stages: Contextualization: Each project begins with a real-world scenario such as designing a lathed shaft or bolt. Planning: Students are grouped heterogeneously with assigned roles (e.g., operator, measurer, safety officer). Project Implementation: Tasks are executed collaboratively, with students referring to structured steps in the jobsheet. Evaluation: Both team and individual performance are assessed using rubrics and personal reflections.

Validation Findings and Analysis

The jobsheet underwent validation by two subject matter experts, a media design expert, and a practicing vocational teacher. The results were as follows: material expert (92%), media expert (87%), and teacher (95%)—placing the product in the "very valid" category. Experts noted several strengths: Material experts appreciated the alignment with core vocational competencies and industry standards. Media experts highlighted the clear layout, supportive visuals, and usability of the sheet. Teachers found the rubric helpful for objectively assessing collaboration and individual contribution. These high scores reflect the well-integrated design, pedagogical clarity, and relevance of the media for real classroom use.

Implementation and Practicality

The implementation trial was conducted with 28 students in Grade XI of the Machining Engineering program. Observations revealed that 93% of CPjBL stages were effectively carried out. Teachers were able to facilitate learning by guiding group discussions, while students actively engaged in hands-on project tasks following the jobsheet instructions. The practicality assessment via questionnaires showed high acceptance: teachers rated it 92.33% and students 84.67%. Teachers appreciated the jobsheet's structure that streamlined instructional delivery. Students noted that it was easy to use, although some needed time to adapt to group-based workflows. This slight divergence in perception is natural and aligns with early adoption trends in collaborative instructional models.

Revisions and Refinements

Minor revisions were made after validation and implementation, particularly to: Refine ambiguous wording in work instructions. Adjust assessment rubrics

to better define indicators of individual and group performance. These improvements enhanced clarity without requiring a complete redesign.

Effectiveness Analysis

The effectiveness of the jobsheet was evaluated using pretest and posttest scores between an experimental group and a control group. The results are summarized below:

Table 1. Jobsheet Effectiveness

Aspects	Experiment Class	Control Class
N-Gain	0.65 (moderate-higt)	0.42
Student Activity (%)	85.00	65.00
Skill Outcomes	88.00	70.00
Posttest Mean	84.20	76.40
Standard Deviation	6.40	4.68
Highest Score	95.00	88.00
Lowest Score	75.00	70.00

These results indicate that students using the CPjBL jobsheet experienced greater improvements in conceptual understanding, collaborative skills, and practical performance.

The results demonstrate that the CPjBL-based jobsheet significantly improved conceptual understanding, practical competencies, and learning engagement. The increase in N-Gain and skill scores suggests that group problem-solving, structured roles, and product-based tasks foster deeper learning.
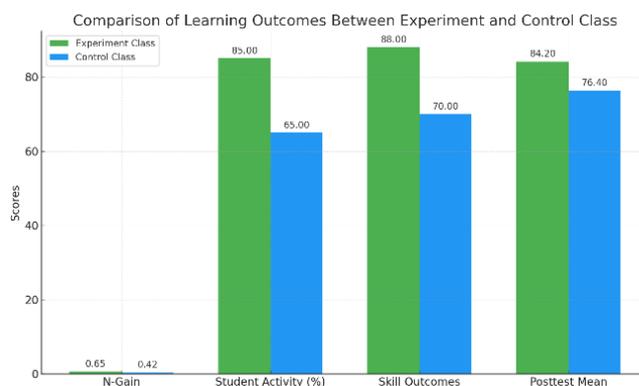

Figure 9. Comparison of learning outcomes between experimental and control classes across n-gain, student activity, skill outcomes, and posttest mean

As shown in Figure 1, the experimental class outperformed the control class in all measured aspects. The CPjBL model's structured collaboration and role assignment contributed to higher engagement and better retention. This is consistent with previous research (Adi et al., 2025; Setyawan et al., 2024) that highlights the impact of project-based collaboration on student performance. Further analysis revealed that skills such as coordination, task division, and safety

compliance were noticeably improved. These findings align with Baligar et al. (2022) and Qizi (2020), who emphasized the importance of soft skills and teamwork in vocational education. In conclusion, the CPjBL-based jobsheet not only addressed practical teaching limitations but also supported the development of holistic competencies essential in industrial settings. Future studies are encouraged to explore scalability and long-term impacts of this instructional tool in other vocational domains.

Comparative and Theoretical Discussion

The effectiveness of this CPjBL-based jobsheet supports findings by Adi et al. (2025) and Setyawan et al. (2024), which highlight the importance of structured, project-based learning in enhancing both technical and collaborative skills. Moreover, it aligns with Qizi (2020), who emphasized the role of soft skill development in vocational education through real-world task engagement.

Specifically, this study observed improvements in: Team communication and coordination during project execution, task accountability among assigned roles, reflective learning, as students documented lessons learned individually. These findings confirm that collaborative projects, when supported with structured media like jobsheets, cultivate industry-relevant behaviors such as teamwork, problem-solving, and responsibility.

Conclusion

Based on the findings and data analysis, it can be concluded that the development of a Collaborative Project Based Learning (CPjBL) jobsheet for the Lathe Machining Engineering subject at SMK Negeri 5 Padang is valid, practical, and effective. Validity: The jobsheet achieved the highest expert validation in the aspects of content relevance and structure, especially in terms of alignment with vocational competencies and clarity of procedural steps. The CPjBL integration—particularly the inclusion of team roles and project rubrics—was highly appreciated for fostering collaborative learning aligned with industry practices. Practicality: Teachers found the jobsheet highly beneficial for facilitating group-based learning and conducting performance-based assessments efficiently. Meanwhile, students valued its clear layout and the structured guidance it provided during practice. The practical aspects most frequently praised were ease of use, support for independent learning, and clarity of role division. Effectiveness: The jobsheet significantly improved learning outcomes in the experimental class, as indicated by an N-Gain score of 0.65 (higher than 0.42 in the control class). The most noticeable skill gains were in teamwork coordination, machining accuracy, and communication during collaborative tasks. This highlights that the embedded CPjBL elements—such as contextual project tasks, role assignments, and reflection prompts—were key contributors to improved engagement and performance. The integration of CPjBL into the jobsheet design not only addressed instructional needs but also fostered the development of 21st-century skills critical for vocational learners. These include problem-solving, collaboration, and responsibility—skills that are essential in modern machining industry settings. This jobsheet shows strong potential for broader implementation in vocational education, particularly in practice-intensive subjects like Lathe Machining, where collaborative learning and real-world task simulations can directly enhance student readiness for industrial work environments. Limitations of this study include the limited sample size and focus on a single vocational subject. Further research is recommended to explore the long-term impacts of CPjBL jobsheets across different vocational disciplines, as well as their scalability through digital or hybrid learning platforms.

Author Contributions
This research article was written by four authors with their respective contributions: Conceptualization, I.D.N and A K; methodology, I.D.N and A.K; formal analysis, I.D.N; data curation, I.D.N; writing-preliminary draft, I.D.N; writing-review, literature review, and editing, A and R reviewers. All authors have read and approved the published version of the manuscript.

Conflicts of Interest
No conflicts of interest are disclosed by the writers.

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