

Effectiveness of Project-Based Learning Digital Jobsheets in Improving the Motivation and Learning Outcomes of Students on the Elements of the Electromechanical Control System

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Abstract: The rapid development of digital technology requires vocational education institutions to implement innovative learning approaches that can improve students' motivation and learning outcomes. This study aimed to analyze the effectiveness of Project Based Learning (PjBL)-based digital jobsheets using the Liveworksheets platform in improving students' motivation and learning outcomes in the Electromechanical Control Systems element. The research employed a quantitative approach with a quasi-experimental method using a Nonequivalent Control Group Design. The study was conducted at SMK Negeri 1 Batam involving 86 eleventh-grade students of Industrial Automation Engineering, divided into an experimental class and a control class. The experimental class was taught using PjBL-based digital jobsheets through Liveworksheets, while the control class used conventional printed jobsheets. Data were collected through learning motivation questionnaires, cognitive achievement tests, performance observations, and documentation. The data were analyzed using descriptive statistics, Independent Sample t-test, and Normalized Gain (N-Gain). The results showed significant differences between the experimental and control groups in learning outcomes (Sig. = 0.009 < 0.05) and learning motivation (Sig. = 0.002 < 0.05). The experimental class achieved a higher average learning outcome score (81.49) and learning motivation score (59.88) than the control class (76.07 and 52.81, respectively). Furthermore, the N-Gain scores indicated moderate improvement in learning outcomes (0.62) and learning motivation (0.48) in the experimental class, which were higher than those of the control class. These findings indicate that PjBL-based digital jobsheets through Liveworksheets are effective in enhancing students' motivation and learning outcomes in vocational education learning.

Keywords: Digital jobsheet; Learning motivation; Learning outcomes; Liveworksheets; PjBL; Vocational education

Introduction

Vocational education has an important role in preparing human resources who are competent, adaptive, and able to face technological developments in the era of the Industrial Revolution 4.0 and Society 5.0. Vocational High Schools (SMK) as vocational education institutions are required to produce graduates who not only master technical skills, but also have the ability to think critically, creatively, collaborate, communicate,

and digital literacy needed by the modern world of work (Perdana, 2019; Priambudi et al., 2022; Yondri et al., 2020). Therefore, the learning process in vocational schools needs to be designed contextually and oriented to learning experiences that allow students to build competencies through activities that resemble real work situations.

One of the approaches that is considered in accordance with the characteristics of vocational education is Project Based Learning (PjBL). This learning

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model places students as the center of learning through active involvement in planning, implementing, and evaluating projects related to real problems (Mufti, 2022; Sakinah et al., 2022; Sujud et al., 2024). Various studies show that PjBL is able to improve high-level thinking skills, problem-solving skills, creativity, collaboration, and learning outcomes of students (Priantari et al., 2020; Rahayuningsih et al., 2022; Swandi et al., 2023). In the context of vocational education, PjBL is also considered relevant because it provides a more authentic learning experience and supports the mastery of work competencies according to industry needs.

In addition to the learning model, learning motivation is an important factor that affects the success of students in achieving optimal learning outcomes. Motivation acts as a driver that determines a person's direction, intensity, and perseverance in learning (Hasan et al., 2022; Ilyas & Liu, 2020; Setiawan, 2023). Students who have high motivation tend to show better enthusiasm, curiosity, independence, and perseverance than students who have low motivation. Therefore, increasing learning motivation is one of the aspects that need attention in learning at vocational schools, especially in productive subjects that require the active involvement of students in practical activities.

Based on the results of initial observations at SMK Negeri 1 Batam, it was found that students' learning motivation in the Electromechanical Control System Elements was still not optimal. Students tend to be passive during practical learning, show less curiosity about the material learned, and have a high level of dependence on the teacher's direction in completing practical tasks. This condition has an impact on the achievement of learning outcomes that have not been maximized, where there are still students who have not reached the Learning Goal Achievement Criteria (KKTP) in the Electromechanical Control System material. This problem shows that the learning process that takes place is not fully able to facilitate the active involvement of students in building their knowledge and skills independently.

One of the factors that is suspected to affect this condition is the use of printed jobsheets which are still conventional. Jobsheets used in practical learning generally only contain work instructions in the form of static text and images, so they are less able to visualize abstract concepts and complex work processes. In fact, the Electromechanical Control System material requires an understanding of the relationship between components, the network workflow, and the ability to analyze and troubleshoot. The limitation of learning media causes students to follow more procedures mechanically without understanding the underlying concepts, thus potentially affecting motivation and learning outcomes achieved.

The development of digital technology provides an opportunity to overcome these problems through the use of digital jobsheets. In contrast to printed jobsheets, digital jobsheets are able to integrate various multimedia elements such as text, images, videos, animations, simulations, and interactive activities that can improve the quality of students' learning experience (Bojórquez-Roque et al., 2026; Chaeruman & Saputra, 2021; Hodaifah et al., 2025; Ritonga et al., 2025). One of the platforms that can be used is Liveworksheets which allows the development of interactive worksheets with drag and drop features, live filling, learning videos, and automatic feedback. Several studies report that the use of Liveworksheet-based media can increase student engagement, independence, and learning outcomes (Husnawati & Nurharini, 2024; Maysara et al., 2023; Syar et al., 2023).

The integration of digital jobsheets with the Project Based Learning model is believed to create more interactive, structured, and student-centered learning. Through this combination, students not only get systematic work guidance, but also the opportunity to explore information, solve problems, and complete projects independently. From a constructivist perspective, an active and meaningful learning experience will help students build a deeper understanding so that it has a positive impact on motivation and learning outcomes (Cahyani & Wahyudiati, 2023; Ratnawati et al., 2020). However, research examining the effectiveness of Project-Based Learning-based digital jobsheets using the Liveworksheets platform in learning Electromechanical Control Systems in vocational schools is still relatively limited.

Based on these conditions, this study offers novelty in the form of the integration of Project-Based Learning-based digital jobsheets using the Liveworksheets platform in the learning of Electromechanical Control Systems at vocational schools. In contrast to previous studies that generally only examined the use of digital media or the implementation of Project Based Learning separately, this study tested the effectiveness of the combination of the two on students' learning motivation and learning outcomes simultaneously. Therefore, this study aims to analyze the effectiveness of the use of Project-Based Learning-based digital jobsheets on improving the learning motivation and learning outcomes of grade XI students on the Elements of the Electromechanical Control System at SMK Negeri 1 Batam.

Method

This study uses a quantitative approach with a quasi-experimental research method to test the

effectiveness of the use of Project Based Learning (PjBL)-based digital jobsheets on learning motivation and student learning outcomes in the Electromechanical Control System Elements. The research design used is Nonequivalent Control Group Design, which is a design that involves an experimental group and a control group without full individual randomization (Sugiyono, 2018).

Table 1. Research design

Group	Pretest	Treatment	Posttest
Experiment	O ₁	X	O ₂
Control	O ₃	-	O ₄

The research was carried out at SMK Negeri 1 Batam in the even semester of the 2025/2026 Academic Year. The research population amounted to 201 students in grade XI of the Industrial Automation Engineering

Expertise Concentration spread across five classes. The research sample was determined using purposive sampling techniques based on the equality of initial abilities, the same teaching teachers, and the similarity of learning materials. Based on these criteria, class XI TOI 2 was obtained as an experimental class and class XI TOI 1 as a control class, with a total of 43 students each.

Learning in both classes uses Project Based Learning syntax which includes problem determination, project planning, project implementation, monitoring, presentation of results, and reflection. The difference in treatment lies in the learning media used. The experimental class used PjBL-based digital jobsheets through the Liveworksheets platform, while the control class used conventional printed jobsheets.

Table 2. Research instrument

Variable	Instruments	Indicator
Learning motivation	Likert scale questionnaire	Perseverance, enthusiasm, curiosity, and independence
Cognitive learning outcomes	Multiple choice test	Application, analysis, and evaluation of electromechanical control systems
Psychomotor learning outcomes	Performance observation sheet	Work preparation, work process, work results, work attitude and timeliness

The learning motivation instrument consisted of 16 valid statements with a reliability coefficient of Cronbach's Alpha of 0.801 which was in the very high category. Meanwhile, the cognitive learning outcome instrument consisted of 20 valid questions with a reliability coefficient of 0.880 which was also in the very high category.

Research data was collected through tests, questionnaires, observations, and documentation. Before hypothesis testing, the data were tested using the Shapiro-Wilk normality test and the Levene homogeneity test to ensure the fulfillment of parametric statistical assumptions (Emmert et al., 2023).

Hypothesis testing was carried out using an Independent Sample t-test to determine the difference in learning motivation and learning outcomes between the experimental class and the control class. The basic formula of the Independent Sample t-test is as follows (Sugiyono, 2017):

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}} \quad (1)$$

The decision making criteria are H₀ is rejected if the significance value (Sig. 2-tailed) < 0.05. In addition, the effectiveness of using PjBL-based digital jobsheets was analyzed using a Normalized Gain (N-Gain) score to determine the level of improvement in learning outcomes and learning motivation before and after

treatment. The N-Gain formula used refers to (Nurfazlina et al., 2025):

$$g = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Maximum score} - \text{Pretest score}} \quad (2)$$

Data analysis was carried out using the help of SPSS software version 26. The data obtained were analyzed descriptively and inferentially to determine the effectiveness of the use of project-based digital jobsheets on learning motivation and student learning outcomes on the Electromechanical Control System Elements.

Result and Discussion

Student Learning Outcomes

The results of the descriptive analysis showed that the initial ability of students in the experimental class and the control class was relatively equivalent. The average pretest score of the experimental class was 52.84, while the control class was 52.42. After being given treatment, the average posttest score of the experimental class increased to 81.49, while the control class reached 76.07. The data showed that the improvement in learning outcomes in the experimental class was higher than in the control class.

Table 3. Descriptive statistics of learning outcomes

Class	Pretest	Posttest
Experiment	52.84	81.49
Control	52.42	76.07

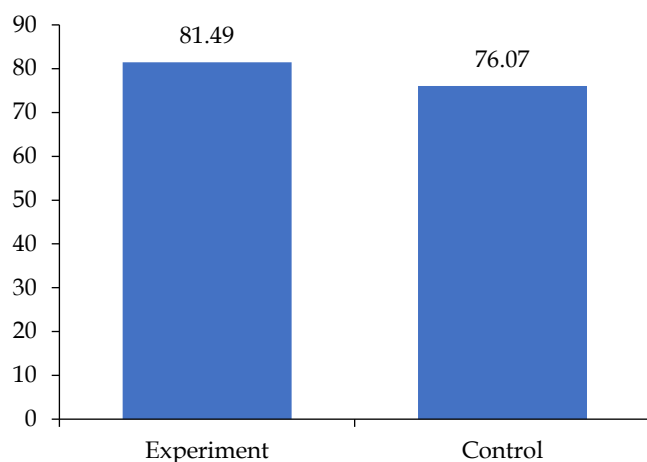
Comparison of Average Learning Outcomes

Figure 1. Average posttest score of experiment and control class

Figure 1 shows that the average learning outcomes of students in the experimental class were higher than those in the control class. These findings indicate that the use of project-based learning-based digital jobsheets provides better learning outcomes than the use of conventional printed jobsheets.

To find out the significance of these differences, an Independent Sample t-test was carried out.

Table 4. Results of the t-test learning outcomes

Variable	t-count	Sig. (2-tailed)	Verdict
Result learning	2.683	0.009	H ₀ Rejected

The significance value of 0.009 was smaller than 0.05, so it can be concluded that there was a significant difference in learning outcomes between the experimental class and the control class.

Students' Learning Motivation

The results of the learning motivation analysis showed an increase in both groups after the learning process. The average learning motivation score of the experimental class increased from 41.21 to 59.88, while in the control.

Table 7. N-Gain analysis results

Variable	Experiment	Category	Control	Category
Result learning	0.62	Medium	0.51	Medium
Learning motivation	0.48	Medium	0.29	Low

Table 5. Descriptive statistics of learning motivation

Class	Pretest	Posttest
Experiment	41.21	59.88
Control	41.47	52.81

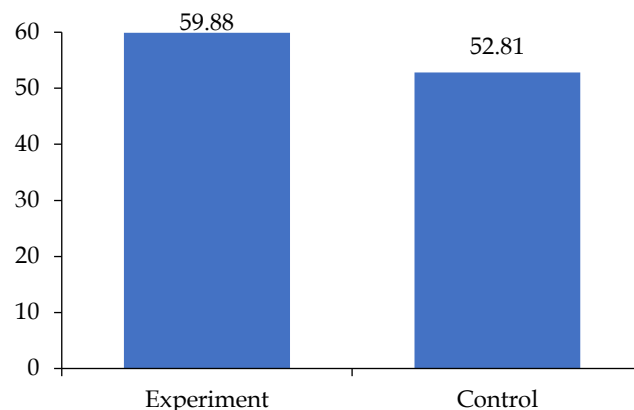
Comparison of Average Learning Motivation

Figure 2. Average learning motivation score after treatment

Figure 2 shows that the students' learning motivation scores in the experimental class were higher than those in the control class. This indicates that the use of PjBL-based digital jobsheets is able to increase students' learning motivation more optimally.

Table 6. Results of the learning motivation t-test

Variable	t-count	Sig. (2-tailed)	Verdict
Learning motivation	3.198	0.002	H ₀ Rejected

The significance value of 0.002 was smaller than 0.05, so it can be concluded that there was a significant difference in learning motivation between the experimental class and the control class.

The Effectiveness of Using Project-Based Learning-Based Digital Jobsheets

The effectiveness of using PjBL-based digital jobsheets was analyzed using the Normalized Gain (N-Gain) score. The results of the analysis showed that the increase in learning outcomes and learning motivation in the experimental class was higher than in the control class.

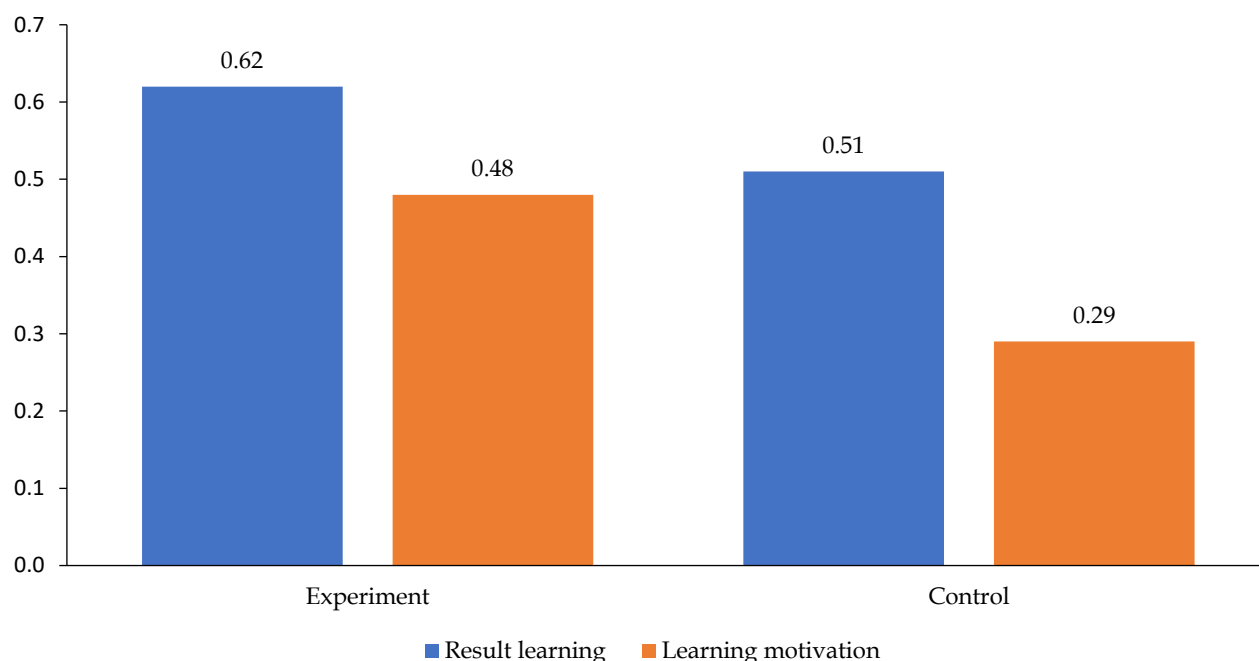
N-Gain Comparison

Figure 3. Effectiveness of improving learning outcomes and learning motivation

Based on Figure 3, the N-Gain value in the experimental class was higher than that of the control class in both learning outcomes and learning motivation. These findings show that the use of PjBL-based digital jobsheets is more effective in improving student learning outcomes and learning motivation.

*Discussion**The Effect of Project-Based Learning-Based Digital Jobsheets on Learning Outcomes*

The results of the study showed that the use of project-based digital jobsheets had a positive effect on student learning outcomes on the Elements of the Electromechanical Control System. These findings were shown by the higher average posttest scores of the experimental class than the control class as well as the results of the Independent Sample t-test which showed a significant difference ($p = 0.009$). These results indicate that the integration of digital jobsheets with the PjBL model is able to create a more effective learning process compared to the use of conventional printed jobsheets.

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The results of this study are in line with the research of Khoerunnisa & Aqwal (2020), Roziqin et al. (2018), and Wa'alin et al., (2023) which shows that the implementation of project-based learning supported by digital media is able to increase student engagement and have a positive impact on learning outcomes.

The Effect of Digital-based Jobsheets on Project Based Learning

The results of the study show that the use of PjBL-based digital jobsheets has a significant effect on students' learning motivation. The learning motivation score of the experimental class was higher than that of the control class with a significance value of 0.002. These findings show that the use of digital media combined

with project-based activities is able to increase students' interest and engagement during the learning process.

The increase in learning motivation occurs because digital jobsheets provide a more interesting and interactive learning experience than printed job sheets. Students gain access to a variety of learning resources in one platform making it easier to understand the material and complete the assigned project assignments. In addition, project activities that require cooperation, exploration, and problem-solving are able to foster students' sense of responsibility and confidence in learning.

This finding can be explained through Self-Determination Theory which states that intrinsic motivation develops when the need for competence, autonomy, and connectedness is met (Taljaard & Sonnenberg, 2019). Through PjBL-based digital jobsheets, students are given the opportunity to manage their learning process independently, work together with groups, and demonstrate skills in completing projects. This condition contributes to a higher increase in learning motivation compared to conventional learning.

The results of this study support the research of Arisanti & Adnan (2021) and Nela (2020) which states that the use of Liveworksheets can increase student engagement, independence, and learning motivation.

The Effectiveness of Using Project-Based Learning-Based Digital Jobsheets

N-Gain analysis shows that the use of PjBL-based digital jobsheets is more effective than conventional jobsheets in improving learning outcomes and student learning motivation. The N-Gain value of learning outcomes in the experimental class was 0.62 and the control class was 0.51, while the N-Gain value of learning motivation in the experimental class was 0.48 and the control class was 0.29.

Although both groups experienced improvements, the experimental class showed a higher improvement. This shows that the integration of digital jobsheets and PjBL is able to create a more interactive, contextual, and student-centered learning environment. In the context of vocational education, this condition is very important because learning is not only oriented towards mastering concepts, but also on the ability to apply knowledge in situations that resemble the world of work.

Overall, the results of the study prove that the use of Project-Based Learning-based digital jobsheets through the Liveworksheets platform is effective in increasing student motivation and learning outcomes on the Electromechanical Control System Elements. These findings have implications that the use of digital technology integrated with active learning models can be one of the innovative strategies to improve the quality

of learning in vocational schools, especially in the field of Industrial Automation Engineering.

Conclusion

Based on the results of the study, it can be concluded that the use of Digital Jobsheets based on Project Based Learning (PjBL) through the Liveworksheets platform is effective in improving learning outcomes and student learning motivation in the Elements of the Electromechanical Control System at SMK Negeri 1 Batam. The results of the hypothesis test showed that there was a significant difference between the experimental class and the control class in learning outcomes (Sig. = 0.009 < 0.05) and learning motivation (Sig. = 0.002 < 0.05). Students who learn using PjBL-based digital jobsheets obtained an average learning outcome of 81.49 and learning motivation of 59.88, higher than students who used conventional jobsheets with an average learning outcome of 76.07 and learning motivation of 52.81. In addition, the results of the N-Gain analysis showed that the increase in learning outcomes in the experimental class was in the medium category ($g = 0.62$) and higher than the control class ($g = 0.51$), while the increase in learning motivation in the experimental class was also in the medium category ($g = 0.48$) and higher than the control class in the low category ($g = 0.29$). These findings show that the integration of PjBL-based digital jobsheets is able to create more interactive, contextual, and student-centered learning, so that it can be an effective learning innovation alternative to improve the quality of learning in vocational education, especially in the Elements of the Electromechanical Control System in vocational schools.

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Author Contributions

Conceptualization, writing—review and editing, J. and D.; methodology, software, formal analysis, investigation, resources, data curation, writing—original draft preparation, visualization, J.; validation, D., Z.Z., R., and F.Y.; supervision, D. and R. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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