Vocational: Journal of Educational Technology
E-ISSN 3063-6639 | P-ISSN 3063-6647
Volume 2. No. 2, December 2025
https://jurnal.smpharapanananda.sch.id/index.php/vocational/

Research Article

The Effect of Project-Based Learning Using E-Learning on Student Learning Outcomes in Vocational Education Courses

Desmira[1], Muhammad Sonhaji Akbar[2], Erik Rahman[2*], Taufik[3], Julius Jonas Mbawala[4]

[1]Faculty of Engineering, Universiti Teknikal Malaysia Melaka, **Malaysia**
[2]Faculty of Engineering, Universitas Negeri Surabaya, **Indonesia**
[3]Institut Agama Islam Negeri Kerinci, **Indonesia**
[4]Saint Augustine's University, **Tanzania**
Correspondence Author: erikrahman@unesa.ac.id

Keywords:
Project-Based Learning, E-Learning, Vocational Education, Learning Outcomes.

Abstract

The integration of digital technology in higher education has accelerated the need for innovative pedagogical approaches that foster active learning and digital competence. Project-Based Learning (PjBL) supported by e-learning provides authentic, technology-driven experiences that are particularly valuable in vocational education, where students must connect theory with practice. This study examined the effect of PjBL using e-learning on student learning outcomes in vocational education courses at the Department of Information Technology Education, Universitas Negeri Surabaya. A quasi-experimental pretest–posttest control group design was employed with 64 purposively selected undergraduate students from the 2024/2025 academic cohort. Participants were assigned equally to an experimental group (n = 32), which received PjBL integrated with e-learning, and a control group (n = 32), which received conventional lecture-based instruction. Data were collected through pretests and posttests and analyzed using descriptive statistics, independent samples t-test, and effect size calculations. Findings revealed that the experimental group achieved significantly higher posttest scores (M = 84.63, SD = 5.21) compared to the control group (M = 76.88, SD = 6.02). The independent samples t-test confirmed the significance of the difference (t = 5.67, p < 0.001), while Cohen's d (d = 1.32) indicated a large effect size. These results demonstrate that integrating PjBL with e-learning substantially improves learning outcomes in vocational education. In conclusion, PjBL supported by e-learning offers an effective instructional strategy for enhancing problem-solving, higher-order thinking, and active student engagement. The findings suggest that aligning pedagogy with digital platforms can optimize learning effectiveness and strengthen students' readiness for professional challenges.

Received: *Jul. 30, 2025.* ***Revised:*** *Aug. 30, 2025.* ***Accepted:*** *Oct. 08, 2025.* ***Published:*** *Dec. 01, 2025.*

How to Cite: Desmira, D., Akbar, M. S., Rahman, E., Taufik, T., & Mbawala, J. J. (2025). The Effect of Project-Based Learning Using E-Learning on Student Learning Outcomes in Vocational Education Courses. *Vocational: Journal of Educational Technology*, *2*(2), 52–61. https://doi.org/10.58740/vocational.v2i2.603

Introduction

Vocational education plays a critical role in preparing students with the knowledge, skills, and competencies required to meet the demands of the rapidly evolving global workforce. In the 21st century, vocational education is not only expected to equip learners with technical expertise but also to foster higher-order skills such as problem-solving, collaboration, adaptability, and creativity [1]. However, despite its importance, vocational education continues to face challenges related to outdated teaching practices, insufficient integration of technology, and limited opportunities for students to engage in authentic, real-world learning experiences [2], [3]. These challenges underscore the urgent need for innovative pedagogical strategies that can enhance student learning outcomes and better align vocational education with industry expectations.

One promising pedagogical model is Project-Based Learning (PjBL), which emphasizes active, student-centered learning through the design and completion of authentic projects. Previous research has shown that PjBL enhances learners' critical thinking, problem-solving, and collaborative skills while fostering deeper understanding of subject matter [4], [5]. Within vocational education contexts, PjBL is particularly relevant as it mirrors professional practices and provides students with opportunities to apply theoretical knowledge to practical tasks. Nevertheless, the successful implementation of PjBL requires careful scaffolding and access to adequate learning resources, which may not always be feasible in traditional classroom settings.

The rapid development of digital technologies offers new possibilities to overcome these barriers through e-learning platforms. E-learning not only provides flexible access to educational resources but also supports collaborative and interactive learning environments beyond the physical classroom [6], [7]. Research has indicated that the integration of e-learning with active learning pedagogies can improve learner engagement, autonomy, and academic achievement [8], [9], [10]. However, empirical studies examining the combined effect of PjBL and e-learning in vocational education remain limited, particularly in the context of higher education institutions in developing countries. This gap highlights the importance of exploring how technology-enhanced PjBL may influence student learning outcomes in vocational education courses.

Against this backdrop, this study aims to investigate the effect of Project-Based Learning using e-learning on student learning outcomes in vocational education courses at Universitas Negeri Surabaya, Indonesia. By comparing the performance of students taught using PjBL supported by e-learning with those taught using conventional methods, this study seeks to provide empirical evidence on the effectiveness of integrating innovative pedagogical models with digital platforms in vocational education. The findings of this study are expected to contribute to the literature on technology-enhanced learning while offering practical insights for educators and policymakers to redesign instructional practices in ways that improve student learning outcomes and prepare graduates for the demands of the modern workforce. Based on the above rationale, the study addresses the following research questions:

1. What are the differences in student learning outcomes between those taught using Project-Based Learning supported by e-learning and those taught using conventional methods in vocational education courses?
2. To what extent does Project-Based Learning using e-learning improve student learning outcomes compared to conventional instruction?

From these research questions, the following hypotheses are formulated:

1. H_1: Students taught using Project-Based Learning supported by e-learning will demonstrate significantly higher learning outcomes than students taught using conventional methods.
2. H_2: The effect size of Project-Based Learning using e-learning on student learning outcomes will be large, indicating a substantial and meaningful improvement in learning performance.

Methodology

A. Research Design

This study employed a quasi-experimental research design using a pretest–posttest control group model. This design was selected because it allows for the examination of causal relationships between the instructional intervention and learning outcomes while preserving ecological validity in a real classroom context.

$$O_1 \; X \; O_2$$

Description:

O_1 = pre-test score (before intervention)

X = intervention (Project-Based Learning (PjBL) Using E-Learning)

O_2 = post-test score (after intervention)

Two groups were involved: an experimental group, which received instruction through Project-Based Learning (PjBL) integrated with e-learning, and a control group, which received conventional lecture-based instruction. Both groups were given a pretest to measure their baseline knowledge and a posttest to assess the impact of the instructional treatment. The difference between the two groups' posttest scores was then analyzed statistically.

B. Participants

The participants in this study were 64 undergraduate students enrolled in the Department of Information Technology Education, Universitas Negeri Surabaya, during the 2024/2025 academic year. A purposive sampling technique was employed to select students who were registered in the vocational education course, as they directly represented the target population. Table 1 presents the demographic profile of the participants.

Table 1. Demographic Profile of Participants

Variable	Category	Experimental Group (n = 32)	Control Group (n = 32)	Total (N = 64)	Percentage (%)
Gender	Male	18	18	36	56.25%
	Female	14	14	28	43.75%
Age (Years)	19	7	6	13	20.31%
	20	10	11	21	32.81%
	21	9	8	17	26.56%
	22	6	7	13	20.31%

From Table 1, it can be observed that the gender distribution was balanced across groups, with males representing 56.25% and females 43.75% of the total participants. The age distribution was relatively homogeneous, with most students aged between 20 and 21 years, reflecting the typical age range of undergraduate students in vocational education courses. Such demographic balance between groups ensured comparability and minimized confounding effects related to gender or age in the subsequent statistical analysis.

C. Data Analysis Techniques

The collected data were analyzed in several steps: descriptive statistics, assumption testing, inferential testing, and effect size analysis. The following formulas were applied.

1. Descriptive Statistics

The mean (X) and standard deviation (SD) for each group were calculated to describe the central tendency and dispersion of student scores:

$$\bar{X} = \frac{\sum_{i=1}^{N} X_i}{N}$$

where:
X = mean score,
X_i= individual score,
N = total number of students.

$$SD = \sqrt{\frac{\sum_{i=1}^{N}(X_i - \bar{X})^2}{N-1}}$$

where:
SD = standard deviation,
X = mean of the group.

These calculations provided the basis for comparing the general trends of performance between the two groups.

2. Assumption Testing

Before conducting hypothesis testing, the assumptions of normality and homogeneity of variance were verified. Normality Test (Kolmogorov–Smirnov):

$$D = \sup_x \left| F_n(x) - F(x) \right|$$

where:
$Fn\,(x)$ = empirical distribution function,
$F(x)$ = cumulative distribution function under the null hypothesis of normality,
D = maximum deviation between the two functions.

A value of p>0.05p > 0.05p>0.05 indicates that the data are normally distributed. Homogeneity Test (Levene's Test):

$$W = \frac{(N-k)}{(k-1)} \cdot \frac{\sum_{i=1}^{k} n_i (Z_{i.} - Z_{..})^2}{\sum_{i=1}^{k} \sum_{j=1}^{n_i} (Z_{ij} - Z_{i.})^2}$$

where:
k = number of groups,
n_i = sample size of group iii,
$Z_{ij} = |X_{ij} - X_i|$ = absolute deviation from the group mean.

If p>0.05p > 0.05p>0.05, equal variance across groups can be assumed.

3. **Independent Samples t-test**

To test for statistically significant differences between the two groups' posttest scores, the independent samples t-test was applied:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \qquad df = \frac{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)^2}{\frac{(S_1^2/n_1)^2}{n_1 - 1} + \frac{(S_2^2/n_2)^2}{n_2 - 1}}$$

This ensures a more accurate estimation of variance when group sizes are unequal. The result of p<0.05p < 0.05p<0.05 was considered statistically significant.

4. **Effect Size (Cohen's d)**

To measure the practical significance of the difference, Cohen's d was calculated:

$$d = \frac{\bar{X}_1 - \bar{X}_2}{SD_{pooled}}$$

with pooled standard deviation defined as:

$$SD_{pooled} = \sqrt{\frac{(n_1 - 1)SD_1^2 + (n_2 - 1)SD_2^2}{n_1 + n_2 - 2}}$$

In this study, a large Cohen's d would indicate that PjBL integrated with e-learning had a substantial and educationally meaningful impact on student learning outcomes.

5. **Significance Level**

All tests were conducted with a confidence level of 95% (α=0.05). Statistical analyses were performed using SPSS Version 26.0.

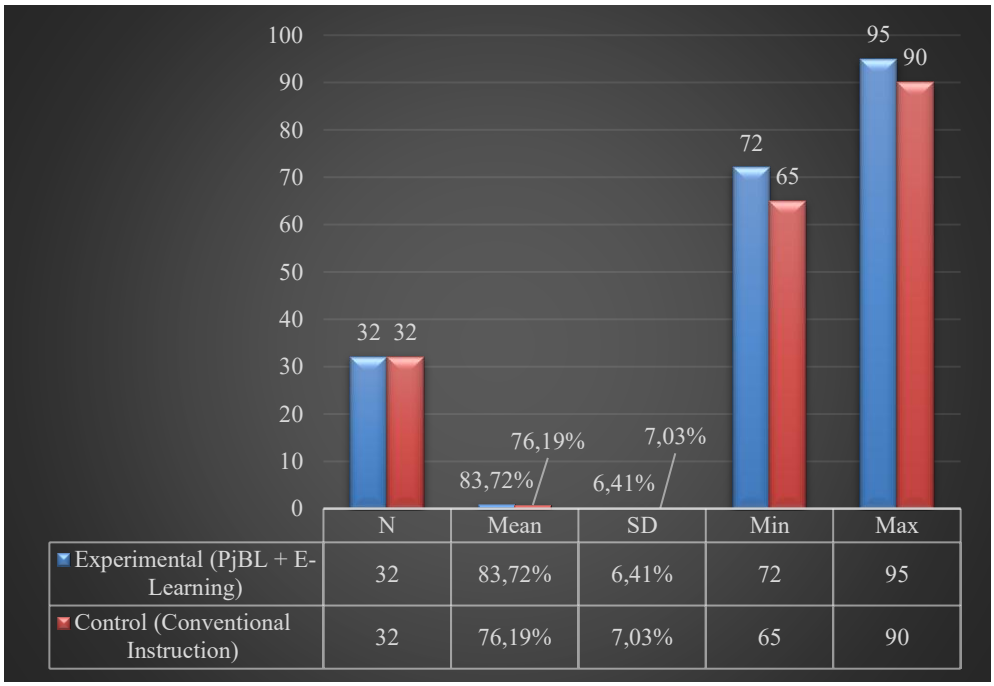
Results and Discussion

The purpose of this study was to examine the effect of implementing Project-Based Learning (PjBL) supported by an e-learning platform on student learning outcomes in vocational education courses. The study was conducted in the Department of Information Technology Education, Universitas Negeri Surabaya,

involving 64 undergraduate students enrolled in the vocational education course during the academic year 2024/2025. Participants were divided into two groups: an experimental group taught using PjBL integrated with e-learning, and a control group taught using conventional lecture-based instruction.

A. Descriptive Statistics

Descriptive analysis was conducted to provide an overview of student performance in both groups. Figure 1 summarizes the distribution of posttest scores.



	N	Mean	SD	Min	Max
Experimental (PjBL + E-Learning)	32	83,72%	6,41%	72	95
Control (Conventional Instruction)	32	76,19%	7,03%	65	90

Figure 1. Descriptive Statistics of Student Learning Outcomes

As illustrated in Figure 1, students in the experimental group achieved higher mean scores (M = 83.72, SD = 6.41) compared to students in the control group (M = 76.19, SD = 7.03). The minimum and maximum scores further indicate that students in the experimental group consistently performed at a higher level, with scores ranging from 72 to 95, whereas the control group scores ranged from 65 to 90. This descriptive evidence suggests a potential positive impact of the PjBL integrated with e-learning approach on student achievement.

B. Assumption Testing: Normality and Homogeneity

Prior to conducting inferential statistical analysis, assumption testing was performed. The Kolmogorov-Smirnov test indicated that the distribution of scores in both groups was normal ($p > 0.05$). Similarly, Levene's Test for Equality of Variances demonstrated that the assumption of homogeneity of variance was met ($p > 0.05$). These results justify the use of parametric testing procedures such as the independent samples t-test.

C. Hypothesis Testing

To examine the research hypothesis, an independent samples t-test was performed to compare student learning outcomes between the two groups. The results are presented in Table 2.

Table 2. Independent Samples t-test Results

Variable	t-value	df	Sig. (2-tailed)	Mean Difference
Learning Outcomes (Post-test)	4.312	62	0.000	7.53

As shown in Table 2, the analysis revealed a statistically significant difference between the two groups ($t(62) = 4.312$, $p < 0.001$). The mean difference of 7.53 points in favor of the experimental group confirms that students who were taught using Project-Based Learning supported by e-learning achieved substantially higher outcomes than those who received conventional instruction.

D. Effect Size

In addition to statistical significance, effect size was computed to determine the magnitude of the difference. Cohen's d was calculated and yielded a value of $d = 1.07$, which represents a large effect size according to Cohen's criteria. This finding indicates that the use of PjBL with e-learning had a strong and meaningful impact on improving student performance, not merely a statistically detectable one.

E. Discussion

The findings of this study demonstrate that the integration of Project-Based Learning (PjBL) with e-learning platforms significantly improves student learning outcomes in vocational education courses. Students in the experimental group who experienced PjBL supported by e-learning achieved substantially higher posttest scores compared to their counterparts in the conventional lecture-based group. The large effect size (Cohen's $d = 1.07$) underscores the strong practical significance of this instructional approach.

These results are consistent with previous studies which have reported that PjBL fosters higher-order thinking skills, problem-solving abilities, and deeper conceptual understanding [4], [5], [6]. The inclusion of e-learning tools appears to amplify these benefits by providing flexible access to instructional resources, facilitating asynchronous collaboration, and enabling timely feedback [7], [8]. Thus, the current study corroborates the view that the combination of PjBL and e-learning can create a learning environment that is not only student-centered but also adaptive to diverse learning needs.

A key explanation for the improved outcomes lies in vocational education, which emphasizes practical application and skill development. PjBL encourages students to engage in authentic tasks that simulate real-world scenarios, thereby enhancing the transferability of knowledge to professional contexts. When complemented with e-learning, students gain additional opportunities for independent exploration and continuous engagement beyond the classroom. This dual modality fosters self-regulated learning, which has been shown to be critical in vocational education settings [7], [8], [10].

Moreover, the collaborative aspects of PjBL, when supported by online platforms, may strengthen peer-to-peer interaction and collective problem-solving. Such collaborative learning has been widely recognized as a factor contributing to deeper understanding and retention of knowledge [9], [10]. In

this study, students in the experimental group reported greater engagement during the project process, suggesting that the interactive features of e-learning platforms played an important role in sustaining motivation and accountability.

Theoretically, the study contributes to the growing body of literature on constructivist learning frameworks, particularly in higher education contexts. By integrating PjBL with digital learning environments, this study supports the argument that learning outcomes are enhanced when learners actively construct knowledge through meaningful tasks mediated by technology (Jonassen, 1999). Practically, the findings have important implications for vocational education curriculum design. Educators and policymakers may consider incorporating technology-enhanced PjBL as a core instructional strategy to improve both cognitive and practical competencies among students.

Nevertheless, this study has certain limitations that should be acknowledged. The research was conducted with a relatively small sample drawn from a single department within Universitas Negeri Surabaya, which may limit the generalizability of the findings. Additionally, the study focused primarily on cognitive learning outcomes; future research could expand to measure affective and psychomotor domains, such as creativity, teamwork, and technical skills. Longitudinal studies are also recommended to assess the sustained impact of PjBL with e-learning on students' professional readiness and career development.

In conclusion, this study confirms that Project-Based Learning integrated with e-learning is a highly effective pedagogical strategy for vocational education. It not only enhances student learning outcomes but also supports active engagement, collaboration, and independent learning. These findings provide a strong rationale for adopting technology-enhanced PjBL approaches in higher education to meet the evolving demands of 21st-century skills development.

Conclusion

This study investigated the effect of Project-Based Learning (PjBL) supported by e-learning on student learning outcomes in vocational education courses at Universitas Negeri Surabaya. The findings revealed that students in the experimental group who experienced PjBL integrated with e-learning achieved significantly higher learning outcomes than those in the control group receiving conventional instruction. The statistical analysis demonstrated not only a significant difference but also a large effect size, confirming the strong influence of this pedagogical approach on improving student achievement. The results highlight that combining PjBL with e-learning provides students with authentic, collaborative, and technology-enhanced learning experiences that promote deeper understanding, critical thinking, and the application of knowledge in real-world contexts. These findings contribute to the literature on constructivist learning and technology-enhanced education by reinforcing the notion that active, student-centered approaches supported by digital platforms can transform vocational education practices. From a practical perspective, this study suggests that vocational

education programs should consider adopting PjBL integrated with e-learning as a core instructional strategy. Such integration can foster not only cognitive gains but also skills essential for 21st-century competencies, including collaboration, self-regulation, and problem-solving. For educators, the study offers an evidence-based rationale to redesign teaching methods in ways that maximize both student engagement and learning outcomes. Despite these contributions, the study has several limitations. The sample was restricted to a single university and department, which may limit the generalizability of the findings. Furthermore, the study primarily assessed cognitive outcomes without exploring broader dimensions such as creativity, teamwork, and long-term knowledge retention. Future research should therefore include larger and more diverse samples, employ longitudinal designs, and incorporate multidimensional assessments of learning outcomes to provide a more comprehensive understanding of the impact of technology-supported PjBL in vocational education. In conclusion, the integration of Project-Based Learning with e-learning represents a powerful and effective instructional model for vocational education. By bridging active learning strategies with digital tools, this approach not only enhances student academic achievement but also prepares learners to meet the evolving challenges of the digital and knowledge-based economy.

Acknowledgments

No funding information from the author.

Author Contributions

Desmira: conceptualization; formal analysis; data curation; methodology, writing - original draft; writing-review and editing. Muhammad Sonhaji Akbar: methodology; data curation, writing-review and editing. Erik Rahman: data curation; writing - review & editing. Taufik: formal analysis; writing - review & editing. Julius Jonas Mbawala: Resources; data curation; writing - review & editing.

Availability of data and materials

All data is available from the authors.

Competing interests

The authors declare no competing interest.

Additional information

No additional information from the authors.

References

[1] V. L. Hariyanto, R. Hidayah, G. N. I. P. Pratama, and R. N. Syamsudin, “Project-Based Learning at Vocational Schools: A Case Study of the Implementation of Entrepreneurship Learning Model”, *International Journal of Instruction*, vol. 16, no. 3, pp. 283–306, Jul. 2023. https://e-iji.net/ats/index.php/pub/article/view/81

[2] Ahmad, S. T., Watrianthos, R., Samala, A. D., Muskhir, M., & Dogara, G. “Project-based learning in vocational education: A bibliometric approach”,

International Journal of Modern Education and Computer Science, vol. 15, no. 4, pp. 43-56, 2023. https://doi.org/10.5815/ijmecs.2023.04.04

[3] Sarwandi, S., Giatman, M., Sukardi, S., & Irfan, D. "Developing mobile-based project-based learning module for project management courses in vocational education", *Jurnal Pendidikan Vokasi*, vol. 9, no. 2, pp. 207-216, 2019. https://doi.org/10.21831/jpv.v9i2.25947

[4] Sepriana, R. "E-Module Project Based Learning (PjBL) using Sigil in Basic Vocational Subjects", *International Journal of Research in Education*, vol. 5, no. 1, 93-100, 2025. https://doi.org/10.26877/ijre.v5i1.879

[5] Muhtar, M., Suryanti, S., Bachri, B. S., Mila, K., Laili, A. Q., Yuliaturosida, E., & Siyam, I. N. "Implementation of Project-Based Learning Model in Vocational High Schools: A Bibliometric Analysis", *Educational Process: International Journal*, 2025. https://doi.org/10.22521/edupij.2025.15.169

[6] Guerra-Macías, Y., & Tobón, S. "Development of transversal skills in higher education programs in conjunction with online learning: relationship between learning strategies, project-based pedagogical practices, e-learning platforms, and academic performance", *Heliyon*, vol. 11, no. 2, 2025. https://doi.org/10.1016/j.heliyon.2024.e41099

[7] Edy, D. L. "Revisiting the impact of project-based learning on online learning in vocational education: Analysis of learning in pandemic Covid-19", In *2020 4th International Conference on Vocational Education and Training (ICOVET)*, pp. 378-381. Sep. 2020. http://dx.doi.org/10.1109/icovet50258.2020.9230137

[8] Distyasa, M. J. E., Winanti, E. T., Buditjahjanto, I. A., & Rijanto, T. "The effect of project-based blended learning (PJB2L) learning model on students learning outcomes", *International Journal for Educational and Vocational Studies*, vol. 3, no. 4, 268-274, 2021. https://doi.org/10.29103/ijevs.v3i4.3959

[9] P. A. Ariawan and I Kadek Suartama, "Improving Student Interests and Learning Outcomes Using Project Based E-Learning Models", *J. Educ. Technol.*, vol. 7, no. 4, pp. 687–697, Jan. 2024. https://doi.org/10.23887/jet.v7i4.64974

[10] Rusnawati, Made Delina, I. Wayan Santyasa, and I. Made Tegeh. "The effect of project-based e-learning models toward learning outcomes and critical thinking skills of vocational high school students." *Jurnal Pendidikan dan Pembelajaran* vol. 27, no. 2, pp. 57-64, 2020. http://dx.doi.org/10.17977/um047v27i22020p057