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The Effect of Project-Based Learning Models on Motivation, Creative Thinking, Critical Thinking, and Learning Outcomes of Students in the Concrete Work Practical Course UNP

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Abstract: The study aims to analyze the effect of Project Based Learning on learning motivation, creativity, critical thinking, and learning outcomes of students in the concrete work practice course at UNP. The research method used a Quasi-Experiment (Semi-Experiment) with a pretest-posttest control group design. The results of the study obtained a p-value of 0.00 < 0.05 or $t_{count} > t_{table}$ with a value of (9.29 > 1.70) for learning motivation, a p-value of 0.00 < 0.05 or $t_{count} > t_{table}$ with a value of (5.36 > 1.70) on student creativity, p = 0.00 < 0.05 or $t_{count} > t_{table}$ with a value of (6.49 > 1.70) on critical thinking, and p-value = 0.00 < 0.05 or $t_{count} > t_{table}$ with a value of (5.06 > 1.70) and (6.44 > 1.70) on cognitive and psychomotor learning outcomes. Thus, it is concluded that there is an effect of the project-based learning model on learning motivation, creativity, critical thinking, and learning outcomes of students in the PTB class at the Faculty of Engineering, Padang State University, Academic Year 2024/2025.

Keywords: Creativity; Critical thinking; Learning motivation; Learning outcomes; PjBL method

Introduction

21st-century education requires students to possess critical thinking, creative, collaborative, and communicative skills (Dewi & Arifin, 2024). For educators and institutions to thrive, it's crucial to recognize that 21st-century transformation will surpass previous centuries, requiring educators not only to provide information but also to equip individuals to flourish in the future (Andri, 2018). Students must acquire 21st-century abilities in order to adapt and compete worldwide in the face of the possibilities and difficulties presented by information and technology advancements in the twenty-first century (Widodo et al., 2020). According to Daryanto et al. (2017), the following are the tenets of 21st-century learning: 1) student-centered learning; 2) student collaboration on projects; 3) contextual learning that is connected to students' everyday lives; and 4) educational institutions that encourage students to interact with their social surroundings. Accordingly, Permendikbud No. 34 of 2018 highlights that in order to promote students' active engagement, the learning process needs to be made engaging, inspirational, and fun.

Both personally and collectively, as well as cognitively and physically, education enhances the calibre and complexity of thought (Sirait et al., 2022). Education can maximise varied resources for practical application and realise human potential (Alawi et al., 2022). Competent human resources are essential to effective and high-quality education, which strives to maximise the potential of each and every student. The government must thus do everything in its power to guarantee that every region of the nation receives a sufficient and excellent education that is suited to their current needs, given the fact that education is highly

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beneficial for national development (Angga et al., 2022; Idhaudin et al., 2019). According to Law No. 20 of 2003, higher education institutions are official organisations charged with achieving the country's educational goals. They want to cultivate students' potential to become individuals who are obedient and committed to God Almighty, possess admirable qualities, are healthy, intelligent, skilful, creative, self-sufficient, and mature into responsible and democratic citizens.

One of the institutions created as a result of the Institute of Teacher Training and Education's broader mandate strategy across Indonesia is Padang State University (UNP). One of three study programs offered by Padang State University's Department of Civil Engineering, Faculty of Engineering (FT-UNP), is the Building Engineering Education Study Program. The goal of this building engineering study program is to produce bachelor's degree holders in building engineering education who can work as teachers and educational staff at polytechnics, job training centres, industrial education and training centres, and vocational high schools (SMK).

An essential part of the curriculum for the Building Engineering and Civil Engineering Study Program is the Concrete Work Practice course, which is offered in the second (even) semester of the Building Engineering Study Program at Padang State University (UNP) Faculty of Engineering. According to SNI standards for simple structures, this course gives students the knowledge, skills, and abilities necessary for concrete masonry practices, such as measuring land for bouwplank installation, excavating, installing aanstampang, installing river stones, reinforcing and casting columns and sloof, and installing brick walls and ceramic wall and floor tiles. Students must exhibit cognitive talents, practical skills, admirable character, and a significant amount of engagement in the learning process in order to pass the current higher education curriculum.

According to the findings of the three lecturers' interviews about learning motivation, the primary issues were that the lecturers' learning model was overly dominant, that their learning motivation for comprehending the fundamentals of building techniques was subpar, that students were not used to performing extremely challenging practical work in the field, and that students lacked self-confidence, all of which could have an impact on their enthusiasm and learning outcomes. Motivation is a driving force behind attaining positive outcomes, including attempts to meet learning objectives (Nursanti et al., 2022). as students are very intrinsically motivated, project-based learning significantly improves their learning results as compared to traditional methods (Muslim et al., 2021).

According to the findings of the lecturers' interviews, the second problem with student creativity is that students come from a variety of educational backgrounds, which leads to a lack of project-based learning that is still not very innovative, a lack of stimulus from lecturers, and a lack of creativity among students. Students' innovative thinking, independence, self-confidence, inventiveness, tolerance, and leadership may all be improved via project-based learning (Sari et al., 2023). By encouraging adventure, curiosity, imagination, and challenge, this teaching strategy might further inspire students' creative potential (Jiang & Pang, 2023). It has been demonstrated that project-based learning enhances students' creativity in media courses, which are marked by a high degree of adaptability and uniqueness (Ummah et al., 2019).

According to the findings of faculty interviews about students' critical thinking, the third issue is that students typically struggle to make decisions based on field data, analyse technical problems in-depth, and only follow procedures in accordance with preexisting guidelines because they are used to lecturers' direct instructions. Students' critical thinking abilities are successfully enhanced by the use of project-based learning methods (Sungkono & Ekaputra, 2023). Critical thinking abilities that students acquire during their education can reduce mistakes made when completing assignments, increasing learning outcomes and enabling precise conclusions (Kurniawati et al., 2020).

The findings of interviews and information gathered from the learning outcomes of students enrolled in the concrete work practice course during the even semester, which ran from January to June (2023–2024), form the basis of the fourth problem. The percentage of A and B marks earned by students in the Concrete Work Practice course is still rather low, with 66% of students receiving A and 24% receiving B on the midterm and final exams, according to data gathered from the professor in charge of the course, which had 15 students. The high percentage of students who obtained C, D, and E grades suggests that learning outcomes in the Concrete Work Practice course are still poor and represent suboptimal and ineffective learning environments.

In order to address some of the aforementioned problems, it is necessary to introduce project-based learning models and conduct efficient learning activities that enhance students' ability to learn on their own by focussing on cognitive, affective, and psychomotor aspects. The Project-Based Learning model is a novel teaching approach that helps students learn information and skills, enhance their ability to think comprehensively, communicate socially, and understand fundamental mathematical concepts by using curriculum content connected to real-world situations (Xiong, 2021). According to Bytyqi (2022), project-based learning is an educational approach where students work on a project that tackles real-world issues or resolves challenging difficulties over an extended length of time (ranging from one week to one semester). The implementation of Project-Based Learning in the Stone and Concrete Practice course received a Respondent Achievement Level (TCR) proportion of 83.85% from the six assessment components, which falls into the good category, according to the findings of a study by Zaus et al. (2023). Thus, the purpose of this study is to examine how the Project-Based Learning paradigm affects learning outcomes, motivation, creativity, and critical thinking in the UNP FT stone and concrete practice course.

The context of building engineering education is where this study is new. This study uses PjBL to concrete masonry practice courses in the FT UNP setting, which is still extremely little. The majority of prior PjBL research has concentrated on biology, mathematics, CNC, and science. A comprehensive picture is offered by the study variables that are employed, which integrate learning objectives, motivation, creativity, and critical thinking into a unified research model. Compared to many studies that simply concentrate on one or two topics, this is more thorough. The use of PjBL also brings students closer to real work practices and realises authentic learning with a real impact on work readiness, which is relevant to the industrial curriculum (SNI) given that this practice includes field operational standards (bouwplank, sloof, columns, and brick/ceramic wall paving). Accordingly, this study anticipates that graduates will possess the solution-oriented, imaginative, and reflective thinking abilities required in the actual construction industry following the implementation of the PjBL approach in the concrete masonry practice course. This will support vocational education's goal of producing competent, self-sufficient, and skilled workers in line with industry demands. Additionally, it will be used as a foundation for developing curricula and instructional methodologies in vocational education, namely in the areas of construction and civil engineering. PjBL, which has been shown to boost critical thinking, creativity, and motivation, may be implemented as a regular learning approach in FT UNP practical courses and other study programs in Indonesia.

Method

A pretest-posttest control group design is employed in this quasi-experimental study approach, and quantitative calculations will be made of the data collected. In this approach, two groups are randomly chosen and given a pretest to ascertain the beginning differences between the experimental class and the control class (Ibrahim et al., 2018) This is further supported by Hardani, (2020), who claims that the experimental and control classes in this study are chosen at random and given a pretest to see how much their scores differ before receiving treatment.

Table 1. The Pretest-Posttest Control Group Design

Group	Pretest	Treatment	Posttest
Experiment	1	X	2
Control	3	Y	4

The population in this study consists of all students enrolled in the Concrete Stone Work Practice course in the 2nd (even) semester of the 2024/2025 academic year, comprising 15 students in PTB 1 class, 15 students in PTB 2 class, 15 students in PTB 3 class, and 15 students in PTB 4 class, resulting in a total of 60 respondents. The sampling technique used is Random Sampling. In this case, the researcher used a lottery method to determine the experimental group in PTB class 1 and the control group in PTB class 2. The instruments used in this study are test and non-test instruments. The test instrument is a test that measures students' cognitive learning outcomes, presented as 15 multiple-choice questions and 5 essay questions.

Result and Discussion

Result

Project-Based Learning was the learning approach employed in this investigation. The pretest was administered at the first meeting before to the start of the learning process, and the posttest was administered at the last meeting following the completion of the learning materials. Through observation of the students' practical learning outcomes, practical assessment was also conducted. Inferential analysis and descriptive analysis were the two data analysis types used to convey the study findings.

Results of Inferential Statistical Analysis

A statistical technique called inferential statistics seeks to make inferences from data gathered from study samples. This study uses a number of tests, including hypothesis, homogeneity, and normalcy tests. Based on the findings of the previous normality and homogeneity tests, the hypothesis may be addressed.

Normality Test

One of the prerequisites for doing a hypothesis test may be this normalcy test. Using the Shapiro-Wilk test and the SPSS for Windows 25.0 program, the normality test findings are utilised to calculate the average scores of students' learning motivation, creativity, critical thinking, and cognitive and psychomotor learning outcomes in the pretest and posttest.

The requirement is that the study data is considered to be normally distributed if the α value is > 0.05 (α is higher than 0.05), and not normally distributed if the α value is < 0.05 (α is less than 0.05). The following table displays the findings of the study data's normalcy test.

Table 2. Results of Normality Tests for Pretest and Posttest in Control and Experimental Classes

Variable	Data	Sig	Taraf Sig (α)	Conclusion
Motivation	Pre Eksp	0.01		
	Post Eksp	0.36	α	
	Pre control	0.12	> 0.05	Normal
	Post control	0.60		
Creativity	Pre Eksp	0.47		
	Post Eksp	0.14	α	Normal
	Pre control	0.17	> 0.05	
	Post kontrol	0.58		
Critical Thinking	Pre Eksp	0.20	α	
	Post Eksp	0.57	> 0.05	Normal
	Pre control	0.22		
	Post control	0.48		
Learning Outcomes	Pre Eksp	0.15	α	
	Post Eksp	0.64	> 0.05	Normal
	Pre control	0.74		
	Post control	0.26		

The normality test results on learning motivation, creativity, critical thinking, and cognitive and psychomotor learning outcomes of students in the experimental class and control class both had significance values above 0.05 in the pretest and posttest, as shown in Table 2. The data were therefore regularly disseminated.

Homogeneity Test

To determine if the samples used PTB 1 class as the experimental class and PTB 2 class as the control class have a homogenous population variance base, the homogeneity test is performed. The Homogeneity of Variances Test in SPSS for Windows 25.0 was used to perform the homogeneity test.

When making a choice, it is necessary to consider whether the data is homogenous if the α value is > 0.05 (more than 0.05) or non-homogeneous if the α value is < 0.05 (less than 0.05). The table 3 displays the findings of the research data homogeneity test.

Based on the data in Table 3, it is clear that the homogeneity test findings for both the pretest and posttest on student learning motivation, creativity, critical thinking, and cognitive and psychomotor learning outcomes are homogeneous or equal. As shown in the table on Student Learning Motivation, the control and experimental classes had a pretest score of 0.905 and a posttest score of 0.902, respectively. Table 3 shows that all variables have homogenous variances.

Table 3. Results of Pretest and Posttest Homogeneity Tests for Control and Experimental Classes

Variable	Statistic	Pretest		Postest	
		control	eksp	control	eksp
Motivation	Sig		0.90		0.90
Creativity	Sig		0.92		0.71
Critical Thinking	Sig		0.94		0.83
Learning outcomes	Sig		0.40		0.50
psychomotor			0.54		

Hypothesis Test

The hypothesis test will be undertaken to determine the learning motivation, creativity, critical thinking, and cognitive and psychomotor learning outcomes of students in the control and experimental classrooms. The Independent Sample T-Test was conducted using the SPSS for Windows 25.0 program. The Project-Based Learning Models has no effect if the Sig value is greater than 0.05. If the Sig value is less than 0.05 or the estimated T is greater than the table T, the learning model has an impact.

Independent T-Test

Motivation Learning

From Figure 1 above, the results of the hypothesis test on learning motivation show that $t_{count} > t_{table}$ (9.29 > 1.701) or the sig value < 0.05 (0.00 < 0.05). Therefore, it can be concluded that H_1 is accepted and H_0 is rejected, meaning that there is an effect of the project-based learning models on students' learning motivation.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Motivasi	Equal variances assumed	.015	.902	9.295	28	.000	7.800	.839	6.081	9.519
	Equal variances not assumed			9.295	27.954	.000	7.800	.839	6.081	9.519

Figure 1. Motivation learning t-test

Creativity

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Kreativitas_Mahasiswa	Equal variances assumed	.138	.714	5.360	28	.000	5.933	1.107	3.666	8.201
	Equal variances not assumed			5.360	27.523	.000	5.933	1.107	3.664	8.203

Figure 2. Student creativity t-test

Based on the data in Figure 2, it can be seen that the results of the hypothesis test for Creativity show that

$t_{calculated} > t_{table}$ (5.36 > 1.70) or the sig value < 0.05 (0.00 < 0.05). Therefore, it can be concluded that H_1 is accepted and H_0 is rejected, meaning that there is an influence of the project-based learning models on student creativity.

Critical Thinking

Based on the data in figure 3, it can be seen that the results of the hypothesis test for Critical Thingking show that $t_{-count} > t_{-table}$ (6.49 > 1.70) or the sig value < 0.05 (0.00 < 0.05). Therefore, it can be concluded that H_1 is accepted and H_0 is rejected, meaning that there is an influence of the project-based learning models on students' critical thinking.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Berpikir_Kritis	Equal variances assumed	.046	.831	6.494	28	.000	7.000	1.078	4.792	9.208
	Equal variances not assumed			6.494	27.932	.000	7.000	1.078	4.792	9.208

Figure 3. Critical thinking t-test

Learning Outcomes

Based on the data in figure 4, it can be seen that the results of the learning outcomes hypothesis test show that $t_{count} > t_{table}$ (5.06 > 1.70) or the significance value < 0.05 (0.00 < 0.05). Therefore, it can be concluded that H_1 is accepted and H_0 is rejected, meaning that there is an effect of the project-based learning models on students' learning outcomes tests.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Hasil_Belajar	Equal variances assumed	.244	.625	2.242	28	.033	2.400	1.071	.207	4.593
	Equal variances not assumed			2.242	27.944	.033	2.400	1.071	.207	4.593

Figure 4. Learning outcomes t-test

Descriptive Analysis of Data

Motivation Learning

Based on Table 4, the data analysis results for the control class, consisting of 15 students, show a pretest average score of 46.47, with the lowest score being 40 and the highest being 59. After the learning process, the posttest average score was 65.27, with the lowest score being 60 and the highest being 70. Meanwhile, the experimental class, also consisting of 15 students, had a pretest average score of 48, with the lowest score being 42 and the highest being 60. After the treatment, the posttest average score was 73.07, with the lowest score being 70 and the highest being 77.

Table 4. Table of Descriptive Statistics Distribution for Learning Motivation

Statistic	Class			
	Control		Experiment	
	Pretest	Posttest	Pretest	Postest
Sample Size	15	15	15	15
Average	46.47	65.27	48	73.07
Std. Deviation	6.18	2.34	6.04	2.25
Lowest Value	40	60	42	70
Highest Value	59	70	60	77

Creativity

Based on Table 5, the data analysis results for the control class, consisting of 15 students, show a pretest average score of 42.60, with the lowest score being 38 and the highest being 46. After instruction, the posttest average score was 80.6, with the lowest score being 74 and the highest being 85. Meanwhile, the experimental class, also consisting of 15 students, had a pretest average score of 44.67, with the lowest score being 40 and the highest being 49. After the intervention, the posttest average score was 86.53, with the lowest score being 82 and the highest being 90.

Table 5. Table of Descriptive Statistics Distribution for Student Creativity

Statistic	Class			
	Control		Experiment	
	Pretest	Posttest	Pretest	Posttest
Sample Size	15	15	15	15
Average	42.60	80.60	44.67	86.33
Std. Deviation	2.74	3.22	2.84	2.82
Lowest Value	38	74	40	82
Highest Value	46	85	49	90

Critical Thinking

Table 6. Distribution of Descriptive Statistics Values for Students' Critical Thinking in Control and Experimental Classes

Statistic	Class			
	Control		Experiment	
	Pretest	Posttest	Pretest	Posttest
Sample Size	15	15	15	15
Average	41.40	80.00	42.33	87.00
Std. Deviation	4.793	2.878	4.320	3.024
Lowest Value	35	76	37	82
Highest Value	50	85	50	92

Based on Table 6, the data analysis results for the control class, consisting of 15 students, show a pretest average score of 41.40, with the lowest score being 35 and the highest being 50. After instruction, the posttest average score was 80.00, with the lowest score being 76 and the highest being 85. Meanwhile, the experimental class, also consisting of 15 students, had a pretest average score of 42.33, with the lowest score being 37 and the highest being 50. After the intervention, the posttest average score was 87.00, with the lowest score being 82 and the highest being 92.

Learning Outcomes

Project Based Learning Cognitive Learning Outcomes

Based on Table 7, the data analysis results for the control class, consisting of 15 students, show a pretest average score of 46.87, with the lowest score being 41 and the highest being 55. After instruction, the posttest average score was 88.07, with the lowest score being 84 and the highest being 93. Meanwhile, the experimental class, also consisting of 15 students, had a pretest average score of 48.47, with the lowest score being 42 and the highest being 54. After the intervention, the posttest average score was 92.93, with the lowest score being 89 and the highest being 97.

Table 7. Descriptive Statistics Distribution Table Cognitive Learning Outcomes

Statistic	Class			
	Control		Experiment	
	Pretest	Posttest	Pretest	Posttest
Sample Size	15	15	15	15
Average	46.87	88.07	48.47	92.93
Std. Deviation	3.77	2.86	4.35	2.37
Lowest Value	41	85	42	89
Highest Value	55	93	54	97

Project Based Learning Psychomotor Learning Outcomes

Control Class

Based on the results of this study, the statistical results of the psychomotor scores of the control class can be seen in the table below:

Table 8. Descriptive Statistical Value Distribution of Student Psychomotor Learning Outcomes in the Control Class

Statistic	Half brick wall
Sample size	15
Average	83.27
Std. Deviation	2.78
Lowest Value	80
Highest Value	89

Based on table 8 above, in the control class for psychomotor scores on half-brick walls, the average value is 83.27, the standard deviation is 2.78, the lowest value obtained by students is 80 and the highest value obtained by students is 89.

Experiment Class

Based on the results of the study, statistical results can be obtained which can be seen in the table below:

Table 9. Distribution of Descriptive Statistics of Student Psychomotor Learning Outcomes in the Experimental Class

Statistik	Half brick wall
Sample size	15
Average	90.13
Std. Deviation	2.75
Lowest Value	86
Highest Value	95

Based on table 9, in the experimental class for psychomotor scores, the average value is 90.13, standard deviation 2.75, the lowest value is 86 and the highest value is 95.

Normality Gain (N-Gain)

The N-Gain normality test was conducted to obtain the results of the increase in student learning motivation in the control and experimental classes.

Learning Motivation

The N-Gain test was carried out with the aim of getting the results of increasing Learning Motivation in the Control class and Experimental class. The results of the calculation can be seen in the table below:

Table 10. Results of Normality Test Analysis of Learning Motivation Gain (N-Gain) in Control and Experimental Classes

				Class Control
	Pretest	Postest	N-Gain	Category
Average	46.46	65.26	0.54	While
			Class	Experiment
Average	48.00	73.06	0.78	High

Based on the data in table 10 above, it can be seen that in the control class, the average N-Gain score obtained is 0.54, which falls into the moderate category. Meanwhile, in the experimental class, the average N-Gain score obtained is 0.78, which falls into the high category.

Creativity

The N-Gain test was carried out with the aim of getting the results of increasing creativity in the Control class and Experimental class. The results of the calculation can be seen in the table 11.

Table 11. Results of Normality Test on Creativity Gain (N-Gain) Analysis of Students in Control and Experimental Classes

				Class Control
	Pretest	Postest	N-Gain	Category
Average	42.6	80.6	0.66	While
			Class	Eksperiment
Average	44.66	86.53	0.75	High

Based on the data in table 11 above, it can be seen that in the control class the average N-Gain value obtained is 0.66 or in the medium category. While in the experimental class the average N-Gain value obtained was 0.75 in the high category.

Critical Thinking

The N-Gain test was carried out with the aim of getting the results of increasing critical thinking in the Control class and Experimental class. The results of the calculation can be seen in the table below:

Table 12. Analysis Test Results (N-Gain) Critical Thinking Students in Control and Experimental Classes

	Pretest	Postest	N-Gain	Class Control Category
Average	41.4	80	0.65	While
			Class	Experiment
Average	42.33	4.66	0.74	High

Based on the data in table 12 above, it can be seen that in the control class the average N-Gain value obtained is 0.65 or in the medium category, while in the experimental class the average N-Gain value obtained is 0.74 in the high category.

Learning Outcomes

The (N-Gain) test was carried out with the aim of obtaining the results of increasing cognitive and psychomotor outcome tests in the control and experimental classes. The calculation results can be seen in the table below.

Table 13. Results of Analysis Test (N-Gain) Cognitive Learning Outcomes of Students in Control and Experimental Classes

	Pretest	Postest	N-Gain	Class Control Category
Average	46.86	88.06	0.69	While
			Class	Experiment
Average	48.46	92.93	0.863	High

Based on the data in table 13 above, it can be seen that in the control class the average N-Gain value obtained is 0.69 or in the medium category. Meanwhile, in the experimental class the average N-Gain value obtained was 0.86 in the high category.

Discussion

The results of the research conducted on PTB 1 class as the experimental class and PTB 2 class as the control class at the Faculty of Engineering, Padang State University, in the course of Stone and Concrete Work Practice, using the Project Based Learning method with the material taught using job sheets in the experimental class, while the control class used the Demonstration Learning Method, which is often used by lecturers of the Stone and Concrete Work Practice course at that university.

The results of the descriptive analysis of Learning Motivation show that there is a positive effect in both the control and experimental groups. The research results show that the experimental class implementing the project-based learning method had a higher average learning motivation, increasing from 48.00 (pretest) to 73.07 (posttest), compared to the control class using the demonstration method, which had an average score of 46.47 (pretest) and 65.27 (posttest). This indicates a significant increase in learning motivation by implementing the project-based learning method. Other statistical analysis values such as standard deviation, maximum and minimum values can be observed in Table 4 Descriptive Statistical Analysis of Student Learning Motivation.

Increased student learning motivation is due to the Project Based Learning method, which connects learning to real-world contexts and authentic problems that align with the students' needs. Students can directly see the relationship between theory and practice, fostering a clear sense of purpose in their learning. During the learning process, students feel like they are part of the knowledge creation process because they actively design, implement, and evaluate their projects. This increases emotional engagement, which can boost their learning motivation. In contrast, in the control group, students often only observe the lecturer performing the practice without a thorough understanding of its purpose and real-life applications. Students are passive and simply follow the learning flow entirely determined by the lecturer.

The explanation regarding learning motivation is also related to research conducted by (Wajdi, 2022), which found that students with high motivation achieved a more significant improvement in learning outcomes in the PjBL group compared to the direct learning group. (Supriyanto, 2023) noted an increase in students' learning motivation from the low category (62.5%) to very high (84.4%) after the implementation of collaborative PjBL on science material. Mahardika (2025) showed that the experimental class with PjBL had an average motivation score of 84.74 compared to 67.76 in the control class (conventional method), indicating a significant difference.

The results of the descriptive analysis on Creativity showed a positive effect in both the experimental and control groups. The research findings indicate that the average creativity score was higher, increasing from 44.67 (pretest) to 86.53 (posttest), compared to the control group using the Demonstration method, which had an average score of 42.60 (pretest) and 80.60

(posttest). This indicates a significant increase in student creativity by applying the Project-Based Learning method. Other statistical analysis values such as standard deviation, maximum and minimum values can be observed in Table 5 Descriptive Statistical Analysis of Student Creativity.

The increased creativity of students is due to the Project Based Learning method, which encourages students to think creatively through direct experience in designing and producing tangible products (final product, portfolio, project), whereas in the control class method, students only observe and follow instructions without exploring new ideas. Consistent with the research conducted (Khafah et al., 2023), it was found that the application of PjBL significantly improved students' creative and critical thinking abilities regarding the concept of ecosystems (p value < 0.05) in a quasi-experimental design. (Muslihasari et al., 2024) reported a significant increase in all creativity indicators (fluency, flexibility, elaboration, originality) for PGSD students after implementing PjBL - the results were highly significant and transformative.

The results of the descriptive analysis on students' critical thinking abilities showed that there was a positive effect in both the experimental and control groups. The research results show that the average critical thinking skills were higher, increasing from 42.33 (pretest) to 87 (posttest), compared to the control class where the demonstration method was applied, with an average score of 41.40 (pretest) and 80 (posttest). This indicates a significant increase in students' critical thinking skills when applying the project-based learning method. Other statistical analysis values such as standard deviation, maximum and minimum values can be observed in Table 6 Descriptive Statistical Analysis of Students' Critical Thinking.

The increase in students' critical thinking is due to the Project Based Learning method, which requires students to analyze real-world problems, design solutions, and evaluate their results – a process that deeply stimulates critical thinking. Learning also requires students to gather information, evaluate data, compare alternatives, and then make decisions based on synthesis. The learning process is conducted in small teams; discussions among peers and cross-group reviews stimulate critical reflection. According to research (Musa'ad et al., 2024), it was found that the implementation of PjBL increased students' critical thinking scores from an average of 43.11 to a gain of 0.66, in a pre-experimental design for mathematics subjects. (Santi et al., 2023) used a two-cycle PTK at SDN Purwantoro 1; critical thinking skills increased from an average of 38.57 pre-cycle to 85.71 in cycle II, demonstrating a significant improvement.

The results of the descriptive analysis on the cognitive and psychomotor learning outcomes tests for students showed that the cognitive learning outcomes tests had a positive effect on both the experimental and control groups. The research results indicate that the average learning outcomes test score was higher, increasing from 48.47 (pretest) to 92.93 (posttest), compared to the control group, which, using the Demonstration method, had an average score of 46.87 (pretest) to 88.07 (posttest). In the psychomotor test, both the experimental and control groups also experienced a significant increase in results for each material. This indicates a significant increase with the application of the Project-Based Learning method. Other statistical analysis values such as standard deviation, maximum and minimum values can be observed in Tables 7 and 8 Descriptive Statistical Analysis of cognitive and psychomotor tests.

The increase in students' learning test results is due to the Project Based Learning method, where activities such as designing, discussing, building, and presenting results make the learning process more active and meaningful, thus improving understanding and evaluation scores. According to Pamungkas (2024), student learning outcomes in PjBL improve because of active participation in discussions, reflections, and group project presentations.

Based on the data obtained from the descriptive analysis, it can be generally concluded that there is an influence of the Project Based Learning method on students' learning motivation, creativity, critical thinking, and learning outcomes. If proven by the N-Gain test using an independent samples t-test, the following values are obtained: $p = 0.00 < 0.05$ or $t_{calculated} > t_{table}$ with a value of $(9.29 > 1.70)$ for learning motivation, $p = 0.00 < 0.05$ or $t_{calculated} > t_{table}$ with a value of $(5.36 > 1.70)$ for student creativity, $p = 0.00 < 0.05$ or $t_{calculated} > t_{table}$ with a value of $(6.49 > 1.70)$, $p = 0.00 < 0.05$ for critical thinking, and $p = 0.00 < 0.05$ or $t_{calculated} > t_{table}$ with a value of $(5.06 > 1.70)$ for cognitive test learning outcomes. In conclusion, H_1 is accepted and H_0 is rejected. According to research conducted by Wajdi (2022), if the results of the hypothesis test are < 0.05, it can be concluded that there is a significant difference in the effect of using the Project Based Learning method compared to the demonstration method in increasing motivation, creativity, critical thinking, and cognitive and psychomotor learning outcomes of students in the PTB class at the Faculty of Engineering, UNP.

Conclusion

The results obtained p value $= 0.00 < 0.05$ or $t_{count} > t_{table}$ with a value of $(9.29 > 1.70)$ on learning motivation, p value $= 0.00 < 0.05$ or $t_{count} > t_{table}$ with a value of (5.36

> 1.70) on student creativity, p = 0. 00 < 0.05 or t_{count} > t_{table} with a value of (6.49 > 1.70) on critical thinking, and p value = 0.00 < 0.05 or t_{count} > t_{table} with a value of (5.06 > 1.70) and (6.44 > 1.70) on cognitive and psychomotor learning. Thus, it can be concluded that the project-based learning model has an impact on the learning motivation, creativity, critical thinking, and learning outcomes of PTB class students at the Faculty of Engineering, State University of Padang for the 2024/2025 Learning Year. The implications of applying this project-based learning model are that students are better prepared to face the world of work because they have experienced real and complex work processes since they were in lectures. Learning becomes more holistic and comprehensive, in line with the character of vocational technology education. Students develop independent competencies, creativity, and professional responsibility, which are needed in the construction field.

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There is no conflict of interest.

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