Comparative Analysis of Pre-Service Physics Teachers Project Results Based on Creative Thinking Skills in Blended Project Based Learning and Case Method in Mechanics

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Abstract. Creative thinking skills (CTS) are one of the 21st-century skills that must be trained for pre-service physics teachers (PPT) as prospective professionals. The results of observations in the mechanics course show that PPT's CTS is still low, with an average score of 4 out of 20 in the less category. In addition, PPTs have never worked on project assignments, so they are not yet skilled at thinking creatively because previous learning only trained cognitive abilities C1-C4. One solution to train CTS is to apply the Blended-Project Based Learning (B-PjBL) model or case method (CM) using e-worksheets assisted by Wizer.me based on Google Sites to work on projects. The purpose of this study is to describe the comparison of PPT project results based on CTS in B-PjBL and CM and to determine PPT's perceptions of project assignments. The study used a mixed method with a sequential explanatory design. The population of this study was all PPT in the 2024/2025 academic year with a total of 483 PPT with the sample consisting of 2 classes with each class consisting of 38 PPT with purposive sampling. The instruments used were project observation sheets, CTS assessment rubrics, questionnaires, and interview questions. This study's data analysis consisted of qualitative and quantitative data analysis. The results of the data analysis showed that the average CTS indicator in B-PBL was better than CM with different categories, namely very good and good. B-PjBL was better at training CTS for flexibility and originality indicators than CM. In addition, PPT positively responded to the projects in B-PjBL and CM, making learning more exciting and enjoyable. Based on the analysis results, it can be concluded that B-PjBL is better than CM in training CTS.

Keywords: project, creative thinking skills, blended-project based learning, case method, mechanics, e-worksheet.

1 Introduction

21st-century learning is directed towards implementing project and case-based learning, so the learning models that are by these demands are the Project Based Learning (PjBL) and Case

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Method models [1], [2]. In addition, the skills that must be trained in the 21st century are creative thinking, critical thinking, communication, and collaboration skills [3], [4].

The results of observations in the mechanics course show that pre-service physics teachers' (PPT) creative thinking skills are still low, with an average score of 4 out of 20, which is in the lower category. In addition, PPT has never worked on project assignments. Hence, they are not yet skilled at thinking creatively because previous learning only trained cognitive abilities, namely remembering (C1), understanding (C2), applying (C3), and analyzing (C4).

Based on a literature study, it was found that one solution that can be done to train creative thinking skills is by implementing the Blended Project Based Learning (B-PjBL) model and case method [5], [6]. The B-PjBL model and case method combine face-to-face learning with online learning. This method involves PPT directly solving problems given by lecturers by creating a project. In solving problems or cases, PPTs are trained to express and realize creative ideas in their projects.

The Blended Project Based Learning (B-PjBL) model is a learning activity that combines face-to-face learning with online learning, which directly involves pre-service physics teachers in solving problems given by lecturers by creating a project. Students apply physics concepts with experiments from the projects they create. The B-PjBL stages consist of six stages, namely the first stage of problem recognition (start with essential question). The second stage of compiling a project design (design project). The third stage of compiling a project schedule (create a schedule). The fourth stage of project creation and lecturer monitoring (monitoring the students and project progress). The fifth stage of testing project results (assess the outcome). The sixth stage of evaluating the process and project results (evaluation of the experience) [1], [5], [7]–[10].

Case-based learning (case method) involves students discussing specific situations and examples of real-world events [11], [12]. This case method is pre-service physics teacher-centered and involves intense interaction between discussion participants. Case-based learning focuses on building knowledge and group work in testing cases. The role of the lecturer as a facilitator and pre-service physics teachers are involved in the case to analyze according to their perspective. Case-based learning involves learners trying to solve questions that do not have a single correct answer. The case method consists of four stages, namely individual preparation (individual analysis and preparation), small discussions (informal small group discussions), class discussions (classroom discussions), and reflection (end-of-class generalization) [2], [3], [6].

Previous research only applied one independent variable by applying B-PjBL or case method only with one dependent variable, namely critical thinking skills, creative thinking skills, or HOTS [1]–[3], [5]–[10], [13]–[15]. The novelty in this study is the analysis conducted by comparing the project results on B-PjBL and case method using comparison design in mixed method research. In addition, other novelties are creating project worksheets based on the Blended Project Learning (B-PjBL) model and case method with an assessment rubric that assesses creative thinking skills that provide contextual problems.

Creative Thinking Skills (CTS) that will be trained through project assignments are a person's thinking skills that emerge because of the potential to create new ideas in solving problems.

The CTS indicators in this study are fluent thinking skills, flexible thinking skills, originality thinking skills, and elaboration thinking skills [16].

Based on the background above, the researcher wants to analyze and compare the results of pre-service physics teacher projects based on creative thinking skills in B-PjBL and the case method on mechanics material.

2 Method

The research used a mixed method with a sequential explanatory design [17], [18]. The research was conducted in the initial stage by collecting data and analyzing it using quantitative methods, then deepened with qualitative methods. The combination of data from both methods is connecting (connecting), with data collection and analysis of both methods carried out separately but made connected. The design for the quantitative research method is the static-group pretest-posttest comparison design [19]–[21].

Table 1. Research Design The Static-Group Pretest-Posttest Comparison Design

Group	Pretest	Treatment	Posttest
I	O_1	X_1	O_2
II	O_3	X_2	O_4

The research sample consisted of 2 classes with 20 pre-service physics teachers in each class. The sampling technique was purposive sampling with the provision that pre-service physics teachers contracted the mechanic's course. The research instruments used were pre-service physics teachers' project worksheets, project assessment rubrics, and a list of questions for semi-structured interviews. Three experts will validate the instruments before being used in the study.

The data collection technique is CTS obtained through project observation sheets in B-PjBL and case methods on mechanics material. Interview data was obtained from interview activities after pre-service physics teachers completed the project, and pre-service physics teachers' perception data was obtained from pre-service physics teachers' perception questionnaires on project assignments given in B-PjBL and case methods on mechanics material.

This study's data analysis consists of qualitative and quantitative data analysis. Quantitative data analysis includes instrument validity testing by experts. The validity of the research instrument uses Aiken's V formula to determine the results of the research instrument validity test from experts with ≥ 0.6 valid categories and < 0.6 invalid categories [7]. The final CTS score may be calculated using the following calculation [9].

$$P = \frac{x}{x_i} \times 100\,\%$$

The variable P is the percentage of the final value, x is the value achieved by pre-service physics teachers' on one indicator, and x_i is the highest value achieved on that indicator. The acquired values are thus classified in Table 2.

Table 2. CTS Categories

Presents (%)	Category
0-39,9	Very less
40-54,99	Less
55,00-69,99	Enough
70,00-84,99	Good
85,00-100,00	Very good

The pre-service physics teachers' perception questionnaire uses the Guttman scale with "Yes" or "No" options. All pre-service physics teachers' scores are then computed using the following equation:

$$P = \frac{f}{N} \times 100\,\%$$

Where P is the percentage of perception values from respondents, f is the number of scores obtained from respondents, and N is the maximum number of scores [22], [23]. Next, the calculation results are interpreted based on the following criteria.

Table 3. CTS Categories

Presents (%)	Category
0	There aren't any
0-25	Fraction
26–49	Almost half
50	Half
51-79	Most of the
76–99	Almost entirely
100	Entirely

The research hypothesis is Ho: There is no difference in pre-service physics teachers' project results based on CTS between B-PjBL and the case method. Ha: There is a difference.

Normality test using SPSS for two samples with the provision that if the Sig. Value> 0.05, then the data is usually distributed [8], [24], [25]. Hypothesis Test: Independent Samples Test. The research hypothesis is as follows: Ho: There is no difference in the average CTS between class B-PjBL and CM. Ha: There is a difference in the average CTS between class B-PjBL and CM. If the Sig. Value < 0.05, then Ho is rejected, and Ha is accepted, meaning there is a difference in the average CTS between class B-PjBL and CM [15].

Qualitative data analysis was done using qualitative descriptive methods based on pre-service physics teachers' interview data [13], [14], [26]. The research procedure can be seen in the following flow diagram.

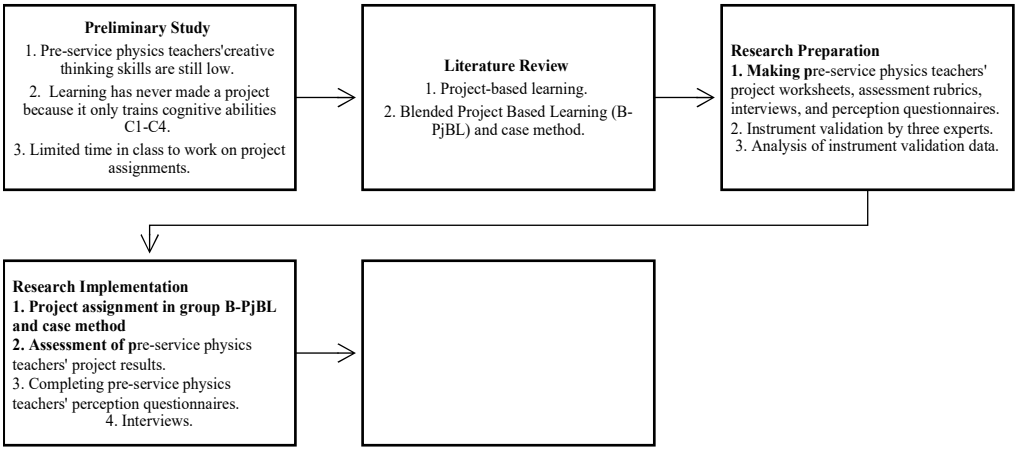

Fig. 1. Research Procedure

2 Results and Discussion

The QR code below summarizes project outcomes and evaluation findings for pre-service physics teachers in classrooms that use the B-PjBL and CM models based on CTS.

Fig. 2. Project Results and Assessment

The results of the analysis of pre-service physics teachers' project assessment data based on CTS in B-PjBL and CM show that the average CTS indicator in B-PjBL is better than CM with different categories, namely excellent and sound with an average CTS score of 4.75 and 4.25. This is because, at the B-PjBL stage, there is an introduction to the problem (starting with an essential question). Pre-service physics teachers can recognize the problem nicely by asking questions so that pre-service physics teachers can then prepare a project design (design project). These questions train PPT to think and find creative ideas to prepare a project design. The results of this research agree with the findings of other investigations by Riak and Mahtari that the PjBL model can train creative thinking skills [10], [27]. In addition, the research results align with Maysyaroh and Dwikoranto's research that the PjBL model encourages students to think creatively by completing real projects that build problem-solving and innovation skills [28].

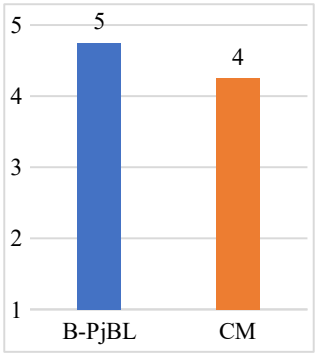

Fig. 3. Average Creative Thinking Skills Indicators

For more details, the average for each CTS indicator in B-PjBL and CM can be seen in the following diagram.

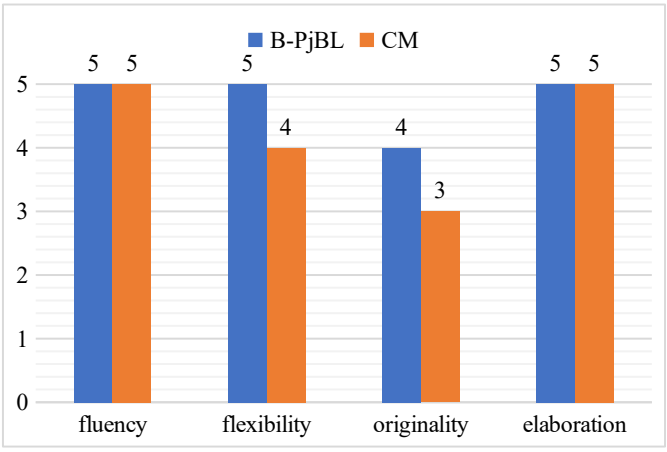

Fig. 4. Average of Each Creative Thinking Skills Indicator

Figure 5 presents data on pre-service physics teachers' responses to project assignments in B-PjBL and CM for ten statements. Statement 1: The appearance of the e-worksheet using Wizer. me based on Google Site for pre-service physics teachers projects in Blended-Project Based Learning (B-PjBL) or Case Method (CM) is attractive. Statement 2: The e-worksheet using Wizer.me based on Google Site for pre-service physics teachers' projects in B-PjBL or CM encourages independent learning. Statement 3: The e-worksheet using Wizer.me based on Google Site for pre-service physics teachers' projects in B-PjBL or CM, supports the application of mechanics concepts. Statement 4: The e-worksheet using Wizer.me based on Google Site for pre-service physics teachers' projects in B-PjBL or CM can be easily accessed. Statement 5: The e-worksheet using Wizer.me based on Google Site for pre-service physics teachers' projects in B-PjBL, or CM makes it easier for lecturers to provide feedback on monitoring the projects given. Statement 6: The contents of the e-worksheet using Wizer.me based on Google Site for pre-service physics teachers' projects in B-PjBL, or CM are complete and detailed for project work. Statement 7: The presentation of e-worksheets using Wizer.me

based on Google Site for pre-service physics teachers' projects in B-PjBL, or CM is easy to fill in by pre-service physics teachers, and the available fields are as needed in completing the project. Statement 8: Instructions for filling in e-worksheets using Wizer.me based on Google Site for pre-service physics teachers' projects in B-PjBL, or CM are clear and easy to understand. Statement 9: The language used in e-worksheets using Wizer.me based on Google Site for pre-service physics teachers' projects in B-PjBL, or CM is simple and easy to understand. Statement 10: The letters used in e-worksheets are simple and easy to read.

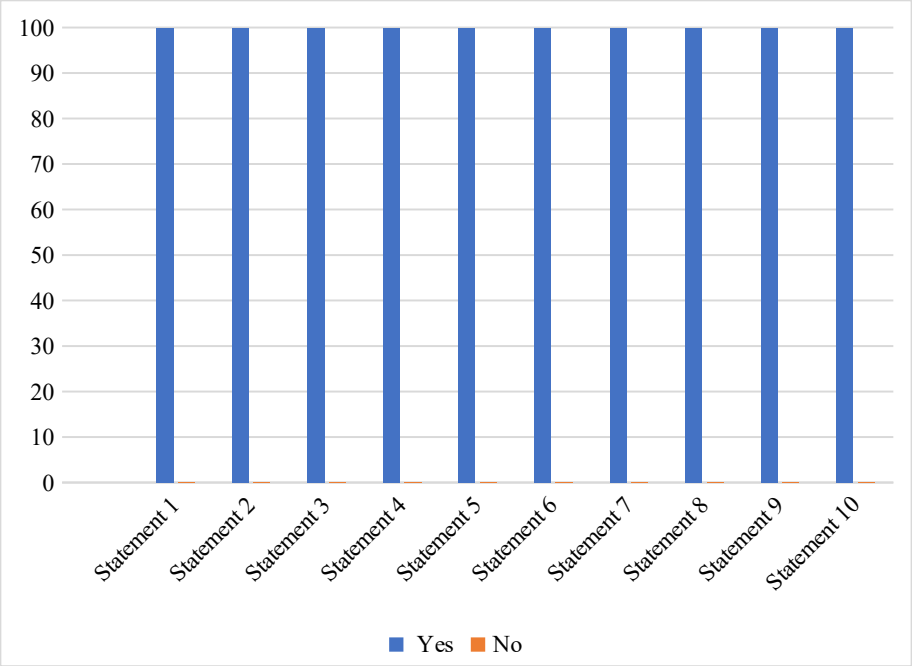

Fig. 5. Percentage of pre-service physics teachers' responses to electronic worksheets for B-PjBL and CM projects on mechanics.

To test the research hypothesis, a normality test was conducted using SPSS for two samples and the results showed that both classes had typically distributed data.

Table 4. Normality Test Results

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
CTS B-PjBL	0,387	20	0,000	0,626	20	0,000
CTS CM	0,348	20	0,000	0,665	20	0,000

a. Lilliefors Significance Correction

The findings of the hypothesis test conducted using SPSS, specifically the independent samples test, indicate a significant disparity in the mean CTS between the BPjBL and CM groups.

Table 5. Independent Sample Test Results

Group Statistics

Class		N	Mean	Std. Deviation	Std. Error Mean
Creative Thinking Skills	Class BPjBL	20	19,400	0,5026	0,1124
	Class CM	20	17,800	1,1965	0,2675

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
CTS	Equal variances assumed	9,771	0,003	5,514	38	0,000	1,6000	0,2902	1,0125	2,1875
	Equal variances not assumed			5,514	25,503	0,000	1,6000	0,2902	1,0029	2,1971

The difference in the average CTS between class B-PjBL and CM can be observed in two CTS indicators: flexibility and originality. B-PjBL is better at training CTS for the flexibility and originality indicators than CM. In the flexibility indicator, pre-service physics teachers in class B-PjBL provide interpretations of a picture in great detail and completeness, apply a concept or principle in different ways very precisely, classify things according to divisions (categories) very precisely, and provide considerations to situations that are different from those given by others very carefully and pay close attention to all aspects that affect the results of the consideration. For the originality indicator, PPT in class B-PjBL thinks very logically and systematically about problems or things that others have not thought of, questions old ways, and tries to think of new ways that are unique and innovative. They also have asymmetry in making pictures or designs very interesting and clear, and after reading or hearing ideas, they work to find new solutions that are very appropriate, effective, and efficient. This study's results align with Hujjatusnaini and Ihsan that B-PjBL trains 21st century skills [1], [29]. In addition, the research results align with Ilma's research that B-PjBL encourages completing projects that build problem-solving skills and student creativity [30].

4 Conclusion

The study results showed that the average CTS indicator in B-PBL was better than CM with different categories, namely excellent and reasonable. B-PjBL was better at training CTS for flexibility and originality indicators than CM. In addition, PPT responded positively to the project in B-PjBL and CM, making learning more exciting and enjoyable. Based on the study results, it can be concluded that B-PjBL is better than CM in training CTS.

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