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Effectiveness of Project Based Laboratory Learning to Increase Student's Science Process Skills and Creativity

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Abstract. The Project Based Laboratory Learning (PJBLL) model is an innovative physics teaching model designed to enhance student's sciences process skills and creativity. Therefore, this research aims to analyze the effectiveness of PJBLL model to improve sciences process skills and creativity physics students who were programmers in Unesa's laboratory. The study design used one-group pretest-posttest design. Data collection methods were conducted by using tests sciences process skills and creativity. Data is analyzed using Paired t-test and N-gain. The results of the study show that there was a significant increase in student's sciences process skills and creativity at $\alpha = 5\%$ with N-gain average of moderate category. Thus, the PjBLL model is effective for enhancing student's sciences process skills and creativity.

1. Introduction

Laboratory-based learning is needed to overcome barriers to the use of problem-based learning (PBL) in a broader relationship, overcome the lack of use of large information that is not appropriate and most teachers do not support its use [1], also needed to increase the low use of assistance to overcome problems [2] discussion of the importance of conducting feedback in learning [3].

Laboratory-based learning is needed to overcome the obstacles in implementing project-based learning (PjBL) in terms of using the time that must be provided to solve complex problems, requiring more costs, managers who are comfortable with traditional classes where they need help in class, transfers that are difficult to find For those who lack or do not master IT, a lot of equipment is available that requires increased electricity, and students who lack understanding of the process will have difficulty in doing experiments and getting information [4].

Considering these two competencies are the instructional objectives of laboratory courses; it is necessary to develop innovative learning to improve planning skills as a rationale for physics laboratory lectures and the development of creativity as key elements for problem solving and the purchase of creative and useful physical products.

The project-based laboratory learning model (PjBLL) begins with Phase 1: Motivating student independence in the project, Phase 2: Organizing needs students on the project, Phase 3: Guiding group project investigations, Phase 4: Monitoring student creativity in developing projects, Phase 5: Presenting and valuing creative products, then ending with Phase 6: Evaluation and reflection [5]. The design of the PjBLL model as PBL and PjBL innovations in physics laboratory courses. Lecturers accustom students to use process skills as basic skills to plan and complete project assignments, examine and discuss examples of creative products as insights for students when designing project assignments. Students are facilitated to develop their creativity and independence in completing project assignments according to their chosen topic, conducting consultations and group discussions to produce creative and useful products.

Process skills include theoretical concepts that are very important in physics learning; because these skills allow a student to produce meaningful information from their own observations and experiences, and they can develop skills while learning scientific information and doing science activities well [6]. Therefore, learning physics becomes more effective when taught using constructivist strategies and conceptual understanding, and the development of process skills greatly facilitates students in the process of scientific inquiry and their future career development [7,8].

Process skills development emphasizes indicators formulating problems, formulating hypotheses, identifying variables, making operational definitions of variables, designing data tables, designing experimental procedures, analyzing data, and drawing conclusions [9-12]. Creativity is a cognitive structure that produces a new view of a form of a problem, not limited to pragmatic results or always seen according to their use [13]. Guilford [14] and [15] define creativity as divergent thinking; involves the production of new and unusual ideas, and unique solutions to solve problems.

Creativity is emphasized in the creative person, the creative process, the creative product, and the creative environment; but in this study instructional objectives are emphasized on creative personalities and creative products, while creative processes and creative environments become accompaniment goals. This is because process skills contribute directly and significantly to the creative process, and the creative environment is a major component of the PJBLL model. Creativity is emphasized on indicators of fluency, flexibility, and originality. In line with [16]; creativity in learning physics, known as scientific creativity, has similarities with creativity in general in terms of fluency, flexibility, and originality; but the emphasis is on creative science experiments, finding problems and solving science problems creatively, as well as creative science activities. In addition, the quality of the creative product produced is emphasized on the suitability of the material with the real needs in school (relevance), the appropriateness of equipment for experimentation, the practicality of manipulating variables, the accuracy in measuring data, the practicality in recording data, product aesthetics, and product safety. The development of this PjBLL is in line with KKNI in the Field of Higher Education and National Standards of Higher Education [17-20].

The effectiveness of the model, the impact of the implementation of the developed model is the level of improvement of process skills and creativity in the minimum criteria of being moderate and significant, the creative products produced are at a minimum good, and the learning environment provides an accompanying impact as determined. The model is expected to make it easier for lecturers to facilitate the development of the process skills and creativity of prospective physics teacher students in physics laboratory courses so that products are produced creative and useful. The problem under study is how the effectiveness of the PjBLL model that has been developed to improve the process skills and creativity of prospective physics teacher students with the aim of describing their effectiveness.

2. Method

The study design used one group pretest-posttest [21]. Learning begins with an initial test (O1); where students in class B and class C work on the process skills test and fill in the student's creativity questionnaire. Lecturers carry out the learning process with the PjBLL (X1) model; where lecturers carry out learning in 32 students of class B and 32 students of class C Physics Education 2016/2017 Academic Year by referring to the phases of the model in 12 meetings. Learning activities end with a final test (O2); where students in both classes take a process skills test, then fill in the creativity questionnaire.

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Process skills are measured by the Process Skills Test Instrument in the form of essay questions. Each item's test items represent indicators formulating the problem, formulating hypotheses, identifying variables, defining operational variables, designing data tables, designing experimental procedures, analyzing data, and drawing conclusions. Process skills tests are undertaken by students before and after the learning process; then the students' answers are assessed by referring to the rubric on the scale 0-4. Student creativity data in the form of positive or negative statements related to student responses regarding fluency, flexibility, and originality in making props and technical instructions.

The value of students' process skills and creativity is calculated using equations; Value = (Number of scores obtained / maximum number of scores) x 100. Obtaining the values above is adjusted to the assessment criteria in Table 1.

Table 1. Criteria for Process Skills Assessment [20]

Score	Assessment criteria	Score	Assessment criteria
85 ≤ score < 100	A	60 ≤ score < 65	C+
80 ≤ score <85	A-	55 ≤ score < 60	C
75 ≤ score < 80	B+	40 ≤ score < 55	D
70 ≤ score < 75	B	0 ≤ score < 40	E
65 ≤ score < 70	B-		

Students are said to be complete indicators of process skills and creativity if the value of process skills and creativity is at least 60 with C criteria. Completion of indicators is classically achieved if 85% of students reach the indicator exhaustiveness standard. Students understand the indicator if the indicator value is at least 2.00 and the completeness of the indicator is achieved if 75% of students have mastered the indicators of process skills and creativity. Levels of improvement in process skills and creativity are calculated using the n-gain equation [21]. The gain of n-gain is adjusted according to the criteria in Table 2.

Table 2. N-Gain Criteria [21]

Score *N-Gain*	Criteria
0,70 < *N-Gain*	High
0,30 ≤ *N-Gain* ≤ 0,70	Medium
N-Gain < 0,30	Low

Initial test data and final test of process skills and creativity are then carried out homogeneity tests, normality tests, and inferential statistical tests with the help of SPSS. Statistical test uses paired t-test. In hypothesis testing using a significance level α = 5% (two-tailed).

3. Results

A summary of the results of the process skills test before and after students take part in the learning process in a broad trial is presented in Table 3.

Table 3. Completeness Indicators and N-Gain of Process Skills

Class	Indicator Process Skills	Pretest				Posttest				*N-Gain*	
		Score	Completeness			Score	Completeness				
			Σ	%	Inf		Σ	%	Inf	<g>	Inf
B	Formulation of the problem	46,88	8	25,00	TT	78,13	28	87,50	T	0,59	Medium
	Hypothesis formulation	40,63	5	15,63	TT	80,47	27	84,38	T	0,67	Medium
	Variable identification	42,97	4	12,50	TT	74,22	25	78,13	T	0,55	Medium
	Definition of operational variables	27,34	3	9,38	TT	72,66	26	81,25	T	0,62	Medium
	Design an observation table	30,47	4	12,50	TT	73,44	25	78,13	T	0,62	Medium
	Designing procedures	28,91	3	9,38	TT	69,53	22	68,75	TT	0,57	Medium

	Data analysis	53,91	9	28,13	TT	79,69	28	87,50	T	0,56	Medium
	Draw a conclusion	64,84	20	62,50	TT	78,13	28	87,50	T	0,38	Medium
C	Formulation of the problem	44,53	2	6,25	TT	78,91	27	84,38	T	0,62	Medium
	Hypothesis formulation	40,63	0	0,00	TT	80,47	28	87,50	T	0,67	Medium
	Variable identification	39,06	2	6,25	TT	75,78	27	84,38	T	0,60	Medium
	Definition of operational variables	25,00	3	9,38	TT	74,22	28	87,50	T	0,66	Medium
	Design an observation table	25,78	3	9,38	TT	74,22	27	84,38	T	0,65	Medium
	Designing procedures	25,00	1	3,13	TT	64,06	17	53,13	TT	0,52	Medium
	Data analysis	50,78	9	28,13	TT	78,91	29	90,63	T	0,57	Medium
	Draw a conclusion	67,19	23	71,88	TT	78,13	27	84,38	T	0,33	Medium

Note: T = Completed, TT = Not Completed

PjBLL can improve the completeness of process skill indicators in class B and class C which were not yet complete (0%) to 87% complete; because all indicators have been completed except designing the experimental procedure. Some students still have difficulty in designing the procedure of the experiment correctly, especially making the experimental design drawings. However, the acquisition of N-gain values indicates the level of improvement of each process skill indicator in the medium criteria.

Table 4. Mastery Pocess Skills of Class B

No	Pretest				Posttest				*N-Gain*	
	Score	Inf	Mastery Indicator		Score	Inf	Mastery Indicator			
			Individual	Clasical			Individual	Clasical	<g>	Inf
M1	40,63	D	TT	13% Incompleteness	71,88	B	T	97% Completeness	0,53	Medium
M2	43,75	D	TT		78,13	B+	T		0,61	Medium
M3	37,50	E	TT		78,13	B+	T		0,65	Medium
M4	50,00	D	TT		78,13	B+	T		0,56	Medium
M5	34,38	E	TT		84,38	A-	T		0,76	High
M6	43,75	D	TT		84,38	A-	T		0,72	High
M7	46,88	D	TT		78,13	B+	T		0,59	Medium
M8	50,00	D	TT		71,88	B	T		0,44	Medium
M9	25,00	E	TT		78,13	B+	T		0,71	High
M10	34,38	E	TT		81,25	A-	T		0,71	High
M11	50,00	D	TT		75,00	B+	T		0,50	Medium
M12	34,38	E	TT		84,38	A-	T		0,76	High
M13	40,63	D	TT		75,00	B+	T		0,58	Medium
M14	65,63	B-	T		71,88	B	T		0,18	Low
M15	43,75	D	TT		75,00	B+	T		0,56	Medium
M16	31,25	E	TT		78,13	B+	T		0,68	Medium
M17	65,63	B-	T		71,88	B	T		0,18	Low
M18	56,25	C	TT		81,25	A-	T		0,57	Medium
M19	34,38	E	TT		81,25	A-	T		0,71	High
M20	34,38	E	TT		71,88	B	T		0,57	Medium
M21	34,38	E	TT		81,25	A-	T		0,71	High
M22	31,25	E	TT		65,63	B-	T		0,50	Medium
M23	65,63	B-	T		71,88	B	T		0,18	Low
M24	43,75	D	TT		78,13	B+	T		0,61	Medium
M25	46,88	D	TT		75,00	B+	T		0,53	Medium
M26	65,63	B-	T		81,25	A-	T		0,45	Medium
M27	34,38	E	TT		68,75	B-	T		0,52	Medium
M28	21,88	E	TT		65,63	B-	T		0,56	Medium
M29	40,63	D	TT		68,75	B-	T		0,47	Medium
M30	31,25	E	TT		56,25	C	TT		0,36	Medium
M31	34,38	E	TT		75,00	B+	T		0,62	Medium
M32	31,25	E	TT		87,50	A	T		0,82	High

Note: T = Completed, TT = Not Completed

Table 5. Mastery Process Skills of Class C

No	Pretest				Posttest				*N-Gain*	
	Score	Inf	Mastery Indicator		Score	Inf	Masteri Indicator			
			Individual	clasical			Individual	clasical	<g>	Inf
M1	40,63	D	TT	3%	65,63	B-	T	94%	0,42	Medium
M2	40,63	D	TT	Not succes	78,13	B+	T	succes	0,63	Medium
M3	25,00	E	TT		78,13	B+	T		0,71	High
M4	34,38	E	TT		78,13	B+	T		0,67	Medium
M5	40,63	D	TT		75,00	B+	T		0,58	Medium
M6	34,38	E	TT		84,38	A-	T		0,76	High
M7	43,75	D	TT		71,88	B	T		0,50	Medium
M8	43,75	D	TT		71,88	B	T		0,50	Medium
M9	25,00	E	TT		43,75	D	TT		0,25	Low
M10	34,38	E	TT		81,25	A-	T		0,71	High
M11	53,13	D	TT		81,25	A-	T		0,60	Medium
M12	40,63	D	TT		87,50	A	T		0,79	High
M13	37,50	E	TT		81,25	A-	T		0,70	Medium
M14	68,75	B-	T		71,88	B	T		0,10	Low
M15	46,88	D	TT		68,75	B-	T		0,41	Medium
M16	34,38	E	TT		78,13	B+	T		0,67	Medium
M17	59,38	C	TT		78,13	B+	T		0,46	Medium
M18	46,88	D	TT		87,50	A	T		0,76	High
M19	21,88	E	TT		90,63	A	T		0,88	High
M20	28,13	E	TT		75,00	B+	T		0,65	Medium
M21	40,63	D	TT		84,38	A-	T		0,74	High
M22	40,63	D	TT		81,25	A-	T		0,68	Medium
M23	50,00	D	TT		75,00	B+	T		0,50	Medium
M24	37,50	E	TT		75,00	B+	T		0,60	Medium
M25	43,75	D	TT		71,88	B	T		0,50	Medium
M26	46,88	D	TT		68,75	B-	T		0,41	Medium
M27	40,63	D	TT		78,13	B+	T		0,63	Medium
M28	34,38	E	TT		68,75	B-	T		0,52	Medium
M29	40,63	D	TT		62,50	C+	T		0,37	Medium
M30	31,25	E	TT		59,38	C	TT		0,41	Medium
M31	28,13	E	TT		75,00	B+	T		0,65	Medium
M32	37,50	E	TT		90,63	A	T		0,85	High

Note: T = Completed, TT = Not Completed

Table 4 and Table 5 show the student's process skills in class B and class C were initially low; because all students have E / D grades, except 4 students of class B (M14, M17, M23, M26) have grades B and 1 student of class C (M14) have grades B. Conversely, the process skills of students after applying the PJBLL model is getting better; because all students in class B and class C get A / B grades, except for 1 class B (M30) student and 3 class C students (M9, M29, M30) still get C / D grades. The application of the PJBLL model was proven to be able to increase completeness classically in class B which was originally 13% (incomplete) to 97% (complete) and class C which was originally 3% (incomplete) to 94% (complete). This is reinforced by the value of N-Gain process skills in both classes generally in the medium / high criteria; except 3 group II students (M14, M17, M23) and 2 group III students (M9, M14) in the low criteria. The SPSS-assisted equality test is then performed which begins the prerequisite tests for normality and homogeneity. The test results show the initial test scores and final test scores of class B and class C meet the requirements for normality and homogeneity, so that in each class paired t-tests are selected whose results are presented in Table 6 bellow.

Table 6. Results of Paired Skill T-Test Results

N	Paired t-test				
	Mean	*Std. Deviation*	*t*	*df*	*P*
32	-72,6	12,8	-32,3	31	<0,00

32	-67,9	15,2	-30,6	31	<0,00

Note: $p < 0{,}05$ (*two-tailed*)

Table 6. shows the mean data of paired t-test results in class B and class C respectively -72.6 and -67.9. With degrees of freedom (df) = 31; the t score of each class gave a value of -32.3 and -30.6 with a significance value of p <0.05. This indicates a significant increase in process skills before and after the implementation of the PjBLL model in both classes.

3.1 Student Creativity

Student creativity data is obtained from the assessment of creative products produced by each group and the results of student creativity questionnaires. Data on student creativity is presented below.

Table 7. Student Creative Product Assessment Results

Class	Creative Product Indicators	Group							
		1		2		3		4	
		Score	Inf	Score	Inf	Score	Inf	Score	Inf
B	1. Relevance to real needs	75	B+	75	B+	75	B+	75	B+
	2. The feasibility of experimental	75	B+	75	B+	100	A	100	A
	3. Practicality of variable manipulation	75	B+	75	B+	75	B+	75	B+
	4. Accuracy of measurement data	75	B+	75	B+	100	A	75	B+
	5. Practical data recording	100	A	75	B+	75	B+	75	B+
	6. Product aesthetics	75	B+	75	B+	50	D	100	A
	7. Product safety	75	B+	75	B+	75	B+	75	B+
	8. Product authenticity	75	B+	75	B+	100	A	75	B+
C	1. Relevance to real needs	75	B+	75	B+	75	B+	100	A
	2. The feasibility of experimental	100	A	75	B+	75	B+	75	B+
	3. Practicality of variable manipulation	100	A	100	A	100	A	75	B+
	4. Accuracy of measurement data	100	A	75	B+	100	A	100	A
	5. Practical data recording	100	A	75	B+	100	A	75	B+
	6. Product aesthetics	75	B+	100	A	75	B+	100	A
	7. Product safety	75	B+	75	B+	100	A	75	B+
	8. Product authenticity	100	A	75	B+	75	B+	75	B+

Table 7 shows students in class B and C are able to produce creative products well; because all aspects of the assessment of creative products include the relevance of the material to real needs in schools, the appropriateness of equipment for the experiment of related material, practicality in manipulating variables, accuracy in data measurement, practicality in data recording, product aesthetics, product safety and authenticity obtain minimum B + assessment criteria; except for group 3 in class B the product aesthetic value was still found in criterion D. This was confirmed by the results of the creativity and questionnaire before and after the learning data presented in Table 8.

Table 8. Completeness of Student Creative Personal Indicators

Class	Indicator	Initial Questionnaire				Final Questionnaire				*N-Gain*	
		Score	Mastery Indicator			Score	Mastery Indicator				
			Σ	%	Inf		Σ	%	Inf	<g>	Inf
B	Fluency	56,64	11	34,38	TT	76,69	28	87,50	T	0,46	Medium
	Flexibility	53,13	5	15,63	TT	73,83	27	84,38	T	0,44	Medium
	Originality	41,54	2	6,25	TT	66,80	26	81,25	T	0,43	Medium
C	Fluency	51,82	10	31,25	TT	73,05	28	87,50	T	0,44	Medium
	Flexibility	51,30	6	18,75	TT	70,57	27	84,38	T	0,40	Medium
	Originality	46,22	3	9,38	TT	68,36	26	81,25	T	0,41	Medium

Note: T = Completed, TT = Not Completed

Table 8 shows that the application of PJBLL in classes B and C is able to increase the completeness of creative personal indicators that had not yet been completely resolved. Strengthened the acquisition of N-gain value that the level of improvement of each creative personal indicator in the criteria is being. Consistent with the results of the analysis of the creative personal understanding of each student in Tables 9 and 10.

Table 9. Creative Personal Understanding Students of Class B

No	Initial Questionnaire				Final Questionnaire				*N-Gain*	
	Score	Inf	Mastery Indicator		Score	Inf	Mastery Indicator			
			Individual	Clasical			Individual	Clasical	<g>	Inf
M1	44,44	D	TT	6%	72,22	B	T	88%	0,50	Medium
M2	48,61	D	TT	not succes	51,39	D	TT	succes	0,05	Low
M3	44,44	D	TT		83,33	A-	T		0,70	Medium
M4	51,39	D	TT		77,78	B+	T		0,54	Medium
M5	62,50	C+	T		83,33	A-	T		0,56	Medium
M6	43,06	D	TT		81,94	A-	T		0,68	Medium
M7	48,61	D	TT		52,78	D	TT		0,08	Low
M8	52,78	D	TT		76,39	B+	T		0,50	Medium
M9	55,56	C	TT		80,56	A-	T		0,56	Medium
M10	50,00	D	TT		68,06	B-	T		0,36	Medium
M11	48,61	D	TT		50,00	D	TT		0,03	Low
M12	59,72	C	TT		77,78	B+	T		0,45	Medium
M13	48,61	D	TT		69,44	B-	T		0,41	Medium
M14	52,78	D	TT		79,17	B+	T		0,56	Medium
M15	58,33	C	TT		88,89	A	T		0,73	High
M16	52,78	D	TT		83,33	A-	T		0,65	Medium
M17	50,00	D	TT		77,78	B+	T		0,56	Medium
M18	40,28	D	TT		43,06	D	TT		0,05	Low
M19	54,17	D	TT		66,67	B-	T		0,27	Low
M20	38,89	E	TT		63,89	C+	T		0,41	Medium
M21	52,78	D	TT		69,44	B-	T		0,35	Medium
M22	52,78	D	TT		76,39	B+	T		0,50	Medium
M23	41,67	D	TT		75,00	B+	T		0,57	Medium
M24	43,06	D	TT		69,44	B-	T		0,46	Medium
M25	48,61	D	TT		70,83	B	T		0,43	Medium
M26	45,83	D	TT		70,83	B	T		0,46	Medium
M27	52,78	D	TT		79,17	B+	T		0,56	Medium
M28	50,00	D	TT		65,28	B-	T		0,31	Medium
M29	52,78	D	TT		84,72	A-	T		0,68	Medium
M30	66,67	B-	T		72,22	B	T		0,17	Low
M31	47,22	D	TT		76,39	B+	T		0,55	Medium
M32	54,17	D	TT		80,56	A-	T		0,58	Medium

Note: T = Completed, TT = Not Completed

Table 9 shows that the creative understanding of class B students was initially low; because students are still in the D / E criteria, except 1 student (M5, M9, M12, M15, M30) in the C / B criterion. Otherwise; the level of creative understanding of class B students after applying the PJBLL model in the B / A criteria, except 4 students (M2, M7, M11, M18) in criterion D and 1 student (M20) are still in criterion C. This is reinforced by the value of N-Gain that the level of improvement of students' creative personality is in the criteria of being medium; except 6 students (M2, M7, M11, M18, M19, M30) whose level of improvement is still in the low criteria. The impact of applying the PJBLL model before and after the learning process also occurs in students in class C as presented in Table 10.

Table 10. Creative Personal Understanding Students of Class C

No	Initial Questionnaire				Final Questionnaire				*N-Gain*	
	Score	Inf	Mastery Indicator		Score	Inf	Masteri Indicator			
			Individual	clasical			Individual	clasical	<g>	Inf
M1	62,50	C+	T	13%	68,06	B-	T	88%	0,15	Low
M2	40,28	D	TT	Not succes	59,72	C	TT	succes	0,33	Medium
M3	43,06	D	TT		76,39	B+	T		0,59	Medium
M4	41,67	D	TT		69,44	B-	T		0,48	Medium

No	Initial Questionnaire				Final Questionnaire				*N-Gain*	
	Score	Inf	Mastery Indicator		Score	Inf	Masteri Indicator			
			Individual	clasical			Individual	clasical	<g>	Inf
M5	47,22	D	TT		83,33	A-	T		0,68	Medium
M6	36,11	E	TT		80,56	A-	T		0,70	Medium
M7	38,89	E	TT		68,06	B-	T		0,48	Medium
M8	43,06	D	TT		77,78	B+	T		0,61	Medium
M9	37,50	E	TT		63,89	C+	T		0,42	Medium
M10	43,06	D	TT		69,44	B-	T		0,46	Medium
M11	45,83	D	TT		48,61	D	TT		0,05	Low
M12	62,50	C+	T		76,39	B+	T		0,37	Medium
M13	59,72	C	TT		69,44	B-	T		0,24	Low
M14	43,06	D	TT		77,78	B+	T		0,61	Medium
M15	44,44	D	TT		76,39	B+	T		0,58	Medium
M16	45,83	D	TT		84,72	A-	T		0,72	High
M17	56,94	C	TT		77,78	B+	T		0,48	Medium
M18	58,33	C	TT		59,72	C	TT		0,03	Low
M19	68,06	B-	T		70,83	B	T		0,09	Low
M20	61,11	C+	T		68,06	B-	T		0,18	Low
M21	58,33	C	TT		72,22	B	T		0,33	Medium
M22	51,39	D	TT		69,44	B-	T		0,37	Medium
M23	54,17	D	TT		59,72	C	TT		0,12	Low
M24	51,39	D	TT		73,61	B	T		0,46	Medium
M25	56,94	C	TT		66,67	B-	T		0,23	Low
M26	43,06	D	TT		68,06	B-	T		0,44	Medium
M27	52,78	D	TT		75,00	B+	T		0,47	Medium
M28	55,56	C	TT		61,11	C+	T		0,13	Low
M29	50,00	D	TT		75,00	B+	T		0,50	Medium
M30	52,78	D	TT		73,61	B	T		0,44	Medium
M31	43,06	D	TT		75,00	B+	T		0,56	Medium
M32	44,44	D	TT		65,28	B-	T		0,38	Medium

Note: T = Completed, TT = Not Completed

Table 10 shows that the creative personal understanding of grade C students was initially still low; because all students are in the D / E criteria, except for 10 students (M1, M12, M13, M17, M18, M19, M20, M21, M25, M28) already in the C / B criteria. After applying the PJBLL model; the level of creative personal understanding of students is in the B / A criteria, except 1 student (M11) is still in the criteria D and 5 students (M2, M9, M18, M23, M28) in criterion C. This is reinforced by the N-Gain value indicating the level improvement of creative personality in class C students is in the medium criteria; except 9 students (M1, M11, M13, M18, M19, M20, M23, M25, M28) in the low criteria. However; the creative personal N-Gain value is positive; so that the application of the PjBLL model is able to improve the creative personality of grade C students. Then the SPSS-assisted similarity test is conducted which begins with the prerequisite tests for normality and homogeneity. The prerequisite test results show the initial questionnaire scores and final questionnaire scores in class B and class C meet the assumptions of normality and homogeneity, so that in each class paired t-tests are selected whose results are presented in Table 11.

Table 11. Creative Personal Paired T-Test Results

N	Paired t-test				
	Mean	*Std. Deviation*	*t*	*df*	*p*
32	-68,2	13,5	-31,2	31	<0,00
32	-66,4	14,6	-32,4	31	<0,00

Note: p <0.05 (two-tailed)

Table 11. shows the t-test results of the paired B class and C class of the mean values of -68.2 and -66.4, respectively. With degrees of freedom (df) = 31; the t score of each class gave a value of -31.2 and

-32.4 with a significance value of $p < 0.05$. This indicates a significant increase in student creative personality before and after the implementation of the PjBLL model in both classes.

4. Discussion
The effectiveness of the PjBLL model shows the achievements of learning outcomes using the model in physics laboratory courses in terms of improving process skills and creativity, as well as student responses which will be described below.

4.1 Process Skills
Process skills of class B, and C students of Physics Education Study Program FMIPA Unesa who program physics physics courses when viewed from the initial test data of process skills were initially still low; because the achievement of indicators in formulating problems, formulating hypotheses, identifying variables, defining operational variables, designing observational data tables, designing experimental procedures, analyzing data, and drawing conclusions nothing has been completed. There are indications that most of these students have not been accustomed to using process skills as basic skills in physics laboratory courses. This finding is in accordance with the results of a survey [22] which found that the process skills of undergraduate students in Biology, Physics and Chemistry of FMIPA Unesa in 2014 had not reached 60 and were less competent in planning and conducting experiments with procedures that were not yet correct. The mastery of students' process skills is still low since 1982 until now [23,22,24,25,26]. Strengthened the results of researchers' preliminary studies that still are found problems in physics laboratory courses, especially the lack of understanding of basic concepts and basic skills in laboratory materials, as well as the resulting products not functioning optimally. Creative products produced by students are still limited to creative and imaginative ideas, so it needs efforts to improve the quality and usefulness of creative products in real life [27].

The final test data shows the completeness of the process skills indicator which was originally 87% complete in the B / C class; although it was still found some students had difficulty making operational definitions of variables and designing experimental procedures. However, the N-Gain value of each process skill indicator shows a level of improvement in the medium criteria. There are indications that the PjBLL model can be used to improve the process skills of students in classes B and C on physics laboratory courses. The role of the PjBLL model in improving student process skills is evident when the lecturer has guided group investigations to understand process skills as basic skills in the project (phase 3); then provide space for the development of creativity and independence of students in completing their project assignments (phase 4). Bearing in mind the components of creativity are process skills [28]; then learning in physics laboratory courses is more effective when lecturers use constructivist strategies, conceptual understanding, and the development of process skills and creativity that facilitate students in scientific inquiry and future career development. The application of the PjBLL model still found incomplete indicators, namely designing experimental procedures. [10] explained the experimental procedure is a step-by-step description of how to change the manipulation variable and observe its effect on the response variable. Therefore, when students have difficulty making operational definitions of variables, they will have difficulty in designing the procedure of the experiment correctly. Strengthened the results of researchers' interviews with several students so that it was found several reasons were they lacked understanding of the physics laboratory equipment, were less accustomed to designing experimental procedures, and had difficulty making the shape of the series. This is consistent with the findings [25], that some of the mistakes made by students in designing the experimental procedure are that the experimental procedure is not yet equipped with the experimental picture, the steps to change the manipulation variable are not appropriate, the measurement of the response variable is not mentioned as a measurement tool or unit. However, the application of the PjBLL model has been shown to be able to improve classical process completeness skills.

The application of the PjBLL model has had a significant impact on improving students' process skills in physics laboratory courses. Consistent with the N-Gain score that the level of improvement of process skills indicators in the criteria is moderate and the level of improvement of each student is generally in the criteria of moderate / high.

Based on the description above, it can be synthesized that the PJBLL model has proven to be effective in improving students' process skills as basic skills in physics laboratory courses. Students are actually able to master process skills well; provided they are accustomed to using it in physics learning activities, scientific investigations, as well as their project assignments. Therefore, a very important task for a lecturer is to foster creative thinking and maximize students' creative products for the benefit of individuals and society [29].

4.2 Student Creativity

The creativity of students of class B and C of Physics Education Study Program FMIPA Unesa when viewed from the initial questionnaire data of creativity was still low; because the achievement of indicators of fluency, flexibility, and originality is incomplete. There are indications that in general students of Class B and C of FMIPA Unesa Physics Education Study Program are not accustomed to being creative individuals in making creative and useful products. This is consistent with the initial findings [26] that the level of creativity of prospective physics teachers from FMIPA Unesa and FKIP ULM in designing learning devices is still low. Creative products produced by students are still limited to creative and imaginative ideas, so it needs efforts to improve the quality and usefulness of creative products in real life [27]. Barriers to creativity often interfere with a person's ability to recognize his own creative ideas [30]. The main problem in the field is that the use of physics laboratories in schools is not yet optimal [31]; so that the initial stock of creativity of students who program laboratory courses is still low. This is confirmed by the results of the researchers' preliminary study that teaching aids products developed by students in physics laboratory courses have not been able to meet the science teaching aids standard and cannot be operationalized for practical activities and instructions.

The final questionnaire data shows that the completeness of the student's creative personal indicators that were initially 0% complete to 100% complete; means that students are able to think smoothly, flexibly, and originally in making physics teaching aids along with their technical instructions. This finding is reinforced by the value of N-Gain which indicates an increased level of creative personal indicators in the medium criteria. This is supported by the theory of complex cognitive processes [32] that creativity can generate new ideas, combine ideas in new ways, or solve problems uniquely. Creativity involves fluency (the number of correct answers that have been produced), flexibility (number of approaches to the answers that have been produced), and originality (the novelty of the answers given). This is reinforced product data that students are able to produce creative products that are relevant to real needs in school, the appropriateness of equipment for related experiments, practicality in manipulating variables, accuracy in data measurement, practicality in data recording, product aesthetics, product safety and authenticity.

The application of the PjBLL model was able to increase classical completeness from initially 6% (class B) and 13% (class C) to 88% (class B, C). The success of the PJBLL model in enhancing student creative personality is directly or indirectly greatly influenced by the phases of the model. Phase 1-2 is preparation; where lecturers try to motivate students to be willing to be creative and independent; then organizing group assignments, topic selection, project schedules, and project logistics that support the development of creativity. Phase 3 supplies process skills as a major component of creativity. This is in accordance with the theory of complex cognitive processes [32] that the main characteristics of creative individuals are mastering knowledge and process skills [32,33,34]. When quality process skills; then students are able to carry out quality scientific processes and quality scientific processes will be able to produce creative products [35]. Phase 4 is at the core of creativity development; where students are given the responsibility to be more creative and in completing the project assignments they choose. Students think more creatively when the environment encourages them to learn more creatively and independently [32]. Phase 5-6 is sharing creative ideas; where students share information to get advice and input related to the processes and creative products produced. This is according to the theory of distributed cognition learning [32] that sharing ideas with others can be improve their understanding,

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because they are encouraged to clarify and organize ideas, elaborate on what is known, find weaknesses in reasoning, and try to enjoy alternative views that are as valid as they have.

The application of the PjJBLL model has had a significant impact on increasing student creativity in physics laboratory courses. Consistent with the value of N-Gain that the level of improvement of creative personal indicators in the criteria is moderate and the level of improvement in general in the criteria of moderate / high.

Based on the description above, it can be synthesized that the PjBLL model has proven to be effective in increasing student creativity in physics laboratory courses. Students have creative potential since they were born; through the right learning process, this creative potential can be maximized to produce creative and useful products. The use of the PjBLL model in physics laboratory courses is believed to be able to explore the creative ideas of prospective physics teacher students in designing and creating creative products, especially physics teaching aids and their technical instructions.

5. Conclusions

The PjBLL model developed was effective, because: (1) significant improvement in students' process skills was in the medium criteria; (2) a significant increase in student creativity in the medium criteria. In addition, students are able to produce creative products in the form of physical teaching aids and technical instructions.

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