



### Research Articles

# Application of PJBL-STEAM and PBL STEAM learning models; improving cognitive learning outcomes, creative thinking and critical thinking of junior high school students in Tanimbar Islands Regency

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### ABSTRACT

STEAM learning is one of the learning innovations that can be applied because it is able to develop 21st century skills. Based on this, the learning models that can be combined with the STEAM approach are project based learning (PjBL) and problem based learning (PBL). The purpose of this study was to determine the effect of the STEAM PjBL learning model on cognitive learning outcomes, creative thinking and critical thinking and the effect of the STEAM PBL learning model on cognitive learning outcomes, creative thinking and critical thinking of junior high school students in Tanimbar Regency. This type of research is a quasi-experimental study. The population in this study were all students of Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara in the even semester of the 2023/2024 academic year with a sample of class VII. Data analysis using Ancova and continued with LSD test with the help of SPSS Version 27. The results of the study showed that there is an influence of the PjBL STEAM learning model on cognitive learning outcomes, creative thinking and critical thinking of junior high school students in Tanimbar Islands Regency with a sig value <0.05 and there is an influence of the PBL STEAM learning model on cognitive learning outcomes, creative thinking and critical thinking of junior high school students in Tanimbar Islands Regency with a sig value <0.05.

**Keywords** : cognitive learning outcomes, creative thinking, critical thinking, PjBL STEAM, PBL STEAM

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### INTRODUCTION

Education is a place for everyone to prepare themselves to face the development of information and communication technology in society. The problem is that most learning is still centered on teachers, resulting in students not mastering 21st century skills optimally, therefore learning reform that shifts from teacher-centered learning to student-centered learning is the answer to efforts to develop 21st century skills in students (Surjana, 2019).

One alternative that teachers can take is to use creative learning models. STEAM learning is one of the learning innovations that can be applied in the era of the 4.0 revolution, because it is able to develop 21st century skills (Mu'minah and Suryaningsih, 2020). STEAM (Science, Technology, Engineering, Art, and Mathematics) is a learning approach that uses five disciplines, namely science, technology, engineering, art, and mathematics as a whole and interrelated as a problem-solving pattern. STEAM learning is also a learning approach that involves students as a whole in exploring and understanding the meaning of the lessons being carried out. The teacher acts as a facilitator and students explore and collaborate in completing their learning tasks. The focus of the STEAM approach is based on the problem-solving learning process, based on this, the learning models that can be combined with the STEAM approach are project-based learning (PjBL) and problem-based learning (PBL). PjBL and PBL are student-centered project-based learning models, which through their application can provide meaningful learning experiences with the final result of PjBL in the form of a product and PBL in the form of a solution to solve problems in the learning process. The student learning experience that is formed is built on the products produced in the project-based learning process.

Several previous studies on the application of PjBL and PBL learning models have been widely studied, such as research by Dewi et al. (2023) regarding the effect of the STEAM-based PjBL learning model on critical thinking skills and students' science learning outcomes, research by Angraini (2021) that the *project-based learning model* is able to influence increasing student activity in learning. This research also greatly supports students to better understand the material presented. Student activity can also affect learning outcomes in the end. So that the learning process that occurs will not be monotonous and boring, students will find it easier to understand the material to be studied with various activities carried out by the project-based learning model. Research by Rineksiane (2022) states that the Project Based Learning Method is being intensively implemented in order to develop students in Indonesia so that they are able to think critically. This is the current focus because in the future these students will become leaders who run the government and become the hope of the Indonesian nation. Currently, critical thinking is very necessary because the challenges of the development of the era are getting more sophisticated every day. If the next generation of the nation cannot think critically in every problem they face, they will not be able to bring Indonesia towards modern progress. As a result, Indonesia will be far behind other countries. The formation of critical thinking is not instant, it requires a long process and also the provision of quite expensive infrastructure. Therefore, the Project Based Learning learning model is applied since elementary school level so that from an early age students are embedded in critical thinking in solving every problem. Robiyanti's research (2021) can be interpreted that the Problem Based Learning learning model can improve student learning outcomes.

In the initial observation conducted at Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan, Junior High School 1 Tanimbar Utara, it was found that teachers in the learning process had used a student-centered cooperative learning model, one of which was the PBL learning model, but the PjBL learning model had not been applied during the learning process, plus the STEAM approach as a new approach to the 21st century had not been applied in the three public schools.

The STEAM approach, when combined with project-based learning models, namely PjBL and PBL, is believed to be able to improve students' learning outcomes, critical thinking and creative thinking, where learning outcomes, creative thinking and critical thinking occur in the cognitive domain. Creative thinking skills are the ability to provide solutions to solve a problem, so that they can create something new or something different from others (Marliani, 2015). By thinking creatively, students are able to view the world from various perspectives, thus creating new solutions to solve problems in real life (Sumarni, 2019). In addition, critical thinking is a cognitive aspect that functions to identify a problem so that it can find a solution and produce a decision or consideration that is processed logically in solving the problem (Khoiriyah, 2018). Therefore, critical thinking skills are very important in developing cognitive abilities and storing information effectively (Herzon, 2018).

## METHODS

This type of research is quasi-experimental because in this study two treatment groups were used which were formed from the beginning so that randomization was not carried out. The population in the study were all students of class VII of Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara in the even semester of the 2023/2024 academic year. The sample used in this study were students of class VII each in VII 1 and VII 2 of Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara. Data collection techniques used written tests and documentation. The data from this study were in the form of students' cognitive learning outcomes, creative thinking and critical thinking which would be analyzed quantitatively using descriptive and inferential statistics. Before conducting inferential analysis, a homogeneity test was carried out using the Levena test and a normality test using the Shapiro - Wilk test. Then if the results of the inferential analysis showed significant results, further LSD testing would be carried out.

## RESULTS AND DISCUSSION

### Results

Data on students' cognitive learning outcomes, creative thinking and critical thinking obtained through initial and final tests are presented in the following table:

**Table 1.** Cognitive learning outcomes of students of Junior High School 1 South Tanimbar

VII-1 (PjBL STEAM)						VII (PBL STEAM)					
Pre-exam			Post-exam			Pre-exam			Post-exam		
Interval	F	%	Interval	F	%	Interval	F	%	Interval	F	%
30-35	4	15,38	70-75	2	7,69	30-35	1	3,84	70-75	2	7,69
36-40	5	19,24	76-80	9	34,62	36-40	8	30,77	76-80	10	38,46
41-45	6	23,08	81-85	4	15,38	41-45	7	26,92	81-85	5	19,23
46-50	7	26,92	86-90	7	26,93	46-50	5	19,23	86-90	9	34,62
51-55	1	3,84	91-95	4	15,38	51-55	4	15,38			
56-60	3	11,54				56-60	1	3,84			
<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>

**Table 2.** Cognitive learning outcomes of students of Junior High School 2 Tanimbar Selatan

VII-1 (PjBL STEAM)						VII (PBL STEAM)					
Pre-exam			Post-exam			Pre-exam			Post-exam		
Interval	F	%	Interval	F	%	Interval	F	%	Interval	F	%
30-35	7	28	70-75	3	12	30-35	11	40,74	70-75	7	25,92
36-40	7	28	76-80	1	4	36-40	12	44,44	76-80	12	44,44
41-45	3	12	81-85	13	52	41-45	1	3,71	81-85	4	14,82
46-50	6	24	86-90	5	20	46-50	3	11,11	86-90	4	14,82
51-55	2	8	91-95	3	12						
<b>Total</b>	<b>25</b>	<b>100</b>	<b>Total</b>	<b>25</b>	<b>100</b>	<b>Total</b>	<b>27</b>	<b>100</b>	<b>Total</b>	<b>27</b>	<b>100</b>

**Table 3.** Cognitive learning outcomes of students of Junior High School 1 Tanimbar Utara

VII-1 (PjBL STEAM)						VII (PBL STEAM)					
Pre-exam			Post-exam			Pre-exam			Post-exam		
Interval	F	%	Interval	F	%	Interval	F	%	Interval	F	%
20-25	2	8	70-75	11	44	25-30	15	57,69	60-65	1	3,85
26-30	10	40	76-80	7	28	31-35	8	30,77	66-70	5	19,23
31-35	5	20	81-85	1	4	36-40	2	7,69	71-75	4	15,38
36-40	3	12	86-90	2	8	41-45	0	0	76-80	8	30,77
41-45	3	12	91-95	4	16	46-50	1	3,85	81-85	5	19,23
									86-90	3	11,54
<b>Total</b>	<b>25</b>	<b>100</b>	<b>Total</b>	<b>25</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>

Based on the table above, it is known that the scores on the initial test for classes using the PjBL STEAM and PBL STEAM learning models show that students have a low level of mastery of the concepts of ecology and biodiversity material. Meanwhile, if you look at the final test, it shows that 100% of students experienced an increase in scores using the PjBL STEAM and PBL STEAM learning models. This means that there is a difference in the increase in scores between before and after students were taught using the PjBL STEAM and PBL STEAM learning models.

**Table 4.** Results of creative thinking at Junior High School 1 South Tanimbar

VII-1 (PjBL STEAM)						VII (PBL STEAM)					
Pre-exam			Post-exam			Pre-exam			Post-exam		
Interval	F	%	Interval	F	%	Interval	F	%	Interval	F	%
13-20	9	34,62	65-70	8	30,77	13-20	16	61,53	54-60	1	3,85
21-25	1	3,85	71-75	3	11,53	21-25	0	0	61-65	4	15,38
26-30	11	42,30	76-80	13	50	26-30	9	34,62	66-70	0	0
31-35	5	19,24	81-85	0	0	31-35	1	3,85	71-75	11	42,30
			86-90	1	3,85				76-80	9	34,62

			90-95	1	3,85				81-85	0	0
									86-90	1	3,85
<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>

**Table 5.** Results of creative thinking at Junior High School 2 Tanimbar Selatan

VII-1 (PjBL STEAM)						VII (PBL STEAM)					
Pre-exam			Post-exam			Pre-exam			Post-exam		
Interval	F	%	Interval	F	%	Interval	F	%	Interval	F	%
13-20	13	50	62-70	7	26,92	13-20	20	74,08	62-70	10	37,03
21-25	0	0	71-75	8	30,76	21-25	0	0	71-75	15	55,56
26-30	13	50	76-80	5	19,24	26-30	6	22,22	76-80	2	7,41
			81-85	0	0	31-35	1	3,70			
			86-90	6	23,08						
<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>27</b>	<b>100</b>	<b>Total</b>	<b>27</b>	<b>100</b>

**Table 6.** Results of creative thinking at Junior High School 1 North Tanimbar

VII-1 (PjBL STEAM)						VII (PBL STEAM)					
Pre-exam			Post-exam			Pre-exam			Post-exam		
Interval	F	%	Interval	F	%	Interval	F	%	Interval	F	%
13-20	11	44	70-75	10	40	13-20	20	76,92	62-70	6	23,08
21-25	0	0	76-80	12	48	21-25	0	0	71-75	12	46,16
26-30	6	24	81-85	0	0	26-30	6	23,08	76-80	8	30,76
31-35	0	0	86-90	3	12						
36-40	6	24									
41-45	1	4									
<b>Total</b>	<b>25</b>	<b>100</b>	<b>Total</b>	<b>25</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>

Based on the table above, it is known that the initial creative thinking test scores for classes using the PjBL STEAM and PBL STEAM learning models, this shows that students have a low level of mastery of the concept of ecology and biodiversity material. Meanwhile, looking at the final test shows that 100% of students experienced an increase in their scores using the PjBL STEAM and PBL STEAM learning models. This means that there is a difference in the increase in scores between before and after students were taught using the PjBL STEAM and PBL STEAM learning models .

**Table 7.** Critical thinking results of South Tanimbar 1 State Middle School

VII-1 (PjBL STEAM)						VII (PBL STEAM)					
Pre-exam			Post-exam			Pre-exam			Post-exam		
Interval	F	%	Interval	F	%	Interval	F	%	Interval	F	%
11-15	9	34,62	37-40	11	42,30	12-15	13	50	34-40	14	53,82
16-20	16	61,54	41-45	9	34,62	16-20	10	38,46	41-45	8	30,72
21-25	1	3,84	46-50	6	23,08	21-25	3	11,54	46-50	4	15,38
<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>

**Table 8.** Critical thinking results at Junior High School 2 Tanimbar Selatan

VII-1 (PjBL STEAM)						VII (PBL STEAM)					
Pre-exam			Post-exam			Pre-exam			Post-exam		
Interval	F	%	Interval	F	%	Interval	F	%	Interval	F	%
12-15	16	61,53	39-45	21	80,76	5-10	1	3,70	29-35	9	33,33
15-20	9	34,62	46-50	5	19,23	11-15	20	74,02	36-40	17	62,9
21-25	1	3,85				16-20	3	11,11	41-45	1	3,70
						21-25	3	11,11			
<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>27</b>	<b>100</b>	<b>Total</b>	<b>27</b>	<b>100</b>

**Table 9.** Critical thinking results at Junior High School 1 North Tanimbar

VII-1 (PjBL STEAM)						VII (PBL STEAM)					
Pre-exam			Post-exam			Pre-exam			Post-exam		
Interval	F	%	Interval	F	%	Interval	F	%	Interval	F	%
12-15	16	61,54	34-40	6	23,08	12-15	20	74,07	34-40	22	81,48
16-20	8	30,77	41-45	10	38,46	16-20	7	25,93	41-45	5	18,52
21-25	2	7,69	46-50	10	38,46						
<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>26</b>	<b>100</b>	<b>Total</b>	<b>27</b>	<b>100</b>	<b>Total</b>	<b>27</b>	<b>100</b>

Based on the table above, it is known that the initial critical thinking test scores of the class using the PjBL STEAM and PBL STEAM learning models have a low level of mastery of the concepts of ecology and biodiversity material. Meanwhile, if you look at the final test, it shows that 100% of students experienced an increase in scores using the PjBL STEAM and PBL STEAM learning models. This means that there is a difference in the increase in scores between before and after students were taught using the PjBL STEAM and PBL STEAM learning models.

**Table 11** Results of hypothesis test 1 Ancova

Learning model	Variables	Signature
PjBL – UAP	Learning outcomes	0.006
	Creative Thinking	0.003
	Critical thinking	0.006

Based on the results of the hypothesis testing in the table above, it can be interpreted as Cognitive Learning Outcomes, obtained a sig value of  $0.006 < 0.05$ . It can be concluded that there is an influence of the PjBL STEAM learning model on the cognitive learning outcomes of class VII students of Junior High School 1 South Tanimbar, Junior High School 2 South Tanimbar and Junior High School 3 North Tanimbar on the material of ecology and biodiversity. Creative Thinking, obtained a sig value of  $0.003 < 0.05$ . It can be concluded that there is an influence of the PjBL STEAM learning model on the creative thinking of class VII students of Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara in studying ecology and biodiversity materials. Critical Thinking, obtained a sig value of  $0.006 < 0.05$ . It can be concluded that there is an influence of the PjBL STEAM learning model on the critical thinking skills of class VII students of Junior High School 1 South Tanimbar, Junior High School 2 South Tanimbar and Junior High School 3 North Tanimbar in studying ecology and biodiversity materials.

Based on the results of the interpretation above, it can be concluded that H1 is accepted, which means that there is an influence of the PjBL STEAM learning model on the cognitive learning outcomes, creative thinking and critical thinking of junior high school students in Tanimbar Islands Regency.

**Table 13.** Results of LSD Test of Hypothesis 1

Learning model	Variables	School	Signature	Information
PjBL – UAP	Learning outcomes	South Tanimbar 1 Middle School	0.007 years	Very different
		South Tanimbar 2 Middle School	0.007 years	Very different
		North Tanimbar 1 Junior High School	0.006	Very different
	Creative Thinking	South Tanimbar 1 Middle School	0.000	Very different
		South Tanimbar 2 Middle School	0.000	Very different

Critical thinking	North Tanimbar 1 Junior High School	0.006	Very different
	South Tanimbar 1 Middle School	0.005	Very different
	South Tanimbar 2 Middle School	0.005	Very different
	North Tanimbar 1 Junior High School	0.006	Very different

The results of the advanced LSD test showed that the cognitive learning outcomes of students at Junior High School 1 Tanimbar Selatan who used the PjBL – STEAM learning model were significantly different from students at Junior High School 2 Tanimbar Selatan who used the PjBL – STEAM learning model and significantly different from students at Junior High School 1 Tanimbar Utara who used the PjBL – STEAM learning model. Then the results of the creative thinking skills of students at Junior High School 1 Tanimbar Selatan who used the PjBL – STEAM learning model were significantly different from students at Junior High School 2 Tanimbar Selatan who used the PjBL – STEAM learning model and significantly different from students at Junior High School 1 Tanimbar Utara who used the PjBL – STEAM learning model. And the critical thinking results of students at Junior High School 1 Tanimbar Selatan who used the PjBL – STEAM learning model were significantly different from students at Junior High School 2 Tanimbar Selatan who used the PjBL – STEAM learning model and significantly different from students at Junior High School 1 Tanimbar Utara who used the PjBL – STEAM learning model.

**Table 12.** Results of the Ancova 2 Hypothesis Test

Learning model	Variables	Signature
PBL – STEAM	Learning outcomes	0.008
	Creative Thinking	0.004 years
	Critical thinking	0.003

Based on the results of the hypothesis testing in the table above, it can be interpreted as follows:

1. Cognitive Learning Outcomes, obtained a sig value of 0.008 <0.05. It can be concluded that there is an influence of the PBL STEAM learning model on the cognitive learning outcomes of class VII students of Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara on the material of ecology and biodiversity.
2. Creative Thinking, obtained a sig value of 0.004 <0.05. It can be concluded that there is an influence of the PBL STEAM learning model on the creative thinking of class VII students of Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara in studying ecology and biodiversity materials.
3. Critical Thinking, obtained a sig value of 0.003 <0.05. It can be concluded that there is an influence of the PjBL STEAM learning model on the critical thinking skills of class VII students of Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara on the material of ecology and biodiversity.

Based on the results of the interpretation above, it can be concluded that H2 is accepted, which means that there is an influence of the PBL STEAM learning model on the cognitive learning outcomes, creative thinking and critical thinking of junior high school students in Tanimbar Islands Regency.

**Table 14.** Results of LSD Test of Hypothesis 2

Learning model	Variables	School	Signature	Information
PBL – STEAM	Learning outcomes	South Tanimbar 1 Middle School	0.003	Very different
		South Tanimbar 2 Middle School	0.003	Very different
		North Tanimbar 1 Junior High School	0.006	Very different
	Creative Thinking	South Tanimbar 1 Middle School	0.008	Very different
		South Tanimbar 2 Middle School	0.008	Very different
		North Tanimbar 1 Junior High School	0.002	Very different

Critical thinking	South Tanimbar 1 Middle School	0.000	Very different
	South Tanimbar 2 Middle School	0.000	Very different
	North Tanimbar 1 Junior High School	0.005	Very different

The results of the advanced LSD test showed that the cognitive learning outcomes of students at Junior High School 1 Tanimbar Selatan who used the PBL-STEAM learning model were significantly different from students at Junior High School 2 Tanimbar Selatan who used the PBL-STEAM learning model and significantly different from students at Junior High School 1 Tanimbar Utara who used the PBL-STEAM learning model. Then the results of the creative thinking skills of students at Junior High School 1 Tanimbar Selatan who used the PBL-STEAM learning model were significantly different from students at Junior High School 2 Tanimbar Selatan who used the PBL-STEAM learning model and significantly different from students at Junior High School 1 Tanimbar Utara who used the PBL-STEAM learning model. And the critical thinking results of students at Junior High School 1 Tanimbar Selatan who used the PBL-STEAM learning model were significantly different from students at Junior High School 2 Tanimbar Selatan who used the PBL-STEAM learning model and significantly different from students at Junior High School 1 Tanimbar Utara who used the PBL-STEAM learning model.

## Discussion

### Cognitive Learning Outcomes

Cognitive learning achievement is assessed based on a comparison of the initial test (Pretest) and final test (Post test) in the PjBL-STEAM class and the PBL-STEAM class. The initial test (Pre-test) is a test carried out at the beginning of the learning process which is used to see the level of initial abilities possessed by students (Asep and Jihad, 2009; Barokah 2019). The initial test is given with the aim of determining the level of initial conceptual knowledge of students regarding the material on ecology and biodiversity and is useful for determining whether students have prepared themselves before taking part in the learning process (Kadir, 2015). The initial test given also aims to prepare students before continuing in learning activities where the initial test can make students' minds focus on the questions being worked on, to determine the level of initial abilities possessed by students regarding the material to be taught and studied and to determine which learning objectives have been mastered and which learning objectives need to be emphasized and given special attention in the ongoing learning process in order to achieve the requirements for completion (Roestiya, 2008).

The final test (Post-Test) aims to determine the level of success both in terms of teachers and students. The final test is given to students when students have gone through a learning process to find out whether the students are truly capable and have completed studying the learning indicators of ecology and biodiversity material. The final test is carried out to assess students' abilities regarding ecology and biodiversity material after or after the learning process that has been undertaken. The final test is carried out immediately after the learning process is completed in one meeting. Therefore, at the final meeting, a final test (Post-test) is carried out as a summary to determine the level of mastery of all cell material that has been given by the teacher and studied by students to determine their level of mastery (Blegur, 2017).

Based on the results of the final stage data analysis contained in the pre-test and post-test results. The results obtained show that the average pre-test and post-test scores of the PjBL-STEAM class are higher than the average score of the PBL-STEAM class (Table 4.1, Table 4.2 and Table 4.3). Descriptive data in Table 4.1, Table 4.2 and Table 4.3 describe the distribution of students in the initial test at Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara who are at a low level of mastery of environmental and biodiversity material while in the final test students experienced an increase in both classes, namely the class taught using the PjBL-STEAM model and the PBL-STEAM class, but it can be seen that the class with the application of the PjBL-STEAM model experienced a higher increase in the final test.

### Creative Thinking

The results of creative thinking are assessments carried out on the initial and final tests of students in learning. This study uses 5 indicators, namely fluency, flexibility, originality, development and assessment. The results of the creative thinking assessment in each initial test of Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan, and Junior High School 1 Tanimbar Utara were low, while in the final test the results of the creative thinking assessment of each class were high (Table 4.4, Table 4.5 and Table 4.6). From the learning process and the results of statistical tests, students in the PjBL-STEAM class are more active and able to develop their creativity through project design activities compared to students in the PBL class, so that PjBL-STEAM can improve students' creative thinking skills better.

The results of the study showed that the PjBL-STEAM learning model can improve students' creative thinking skills. The use of project-based learning models is one of the most effective ways to improve students' brainpower and creative thinking skills (Nasution et al., 2013).

### **Critical Thinking Results**

Critical thinking is a high-level thinking skill emphasizes the process of student activity in solving problems according to the problems submitted or faced, students are expected to be able to identify causes and are guided to find alternatives or solutions in solving a problem, so that reflective and logical conclusions can be drawn (Brigili, 2015). The value of students' critical thinking skills in this study was obtained from formative tests, namely the initial test (Pre-test) and the final test (Post-test).

Based on the research results (Table 4.7, Table 4.8, and Table 4.9) it shows that the students' scores on the initial test of the PjBL-STEAM and PBL-STEAM classes are classified as low, while the final tests of the two classes are classified as high. This means that there is an increase in scores after students take part in learning using the PjBL-STEAM and PBL-STEAM learning models.

On The learning process of integrating the two learning models has several advantages and has the potential to empower students' critical thinking skills. The activities carried out in STEAM-PjBL learning refer to the stages of project-based learning with the provision that STEAM (Science, Technology, Engineering, Arts and Mathematics) is also integrated. The steps are as follows: activities to determine basic questions, prepare project plans, prepare schedules, monitor, assess results and evaluate. The first step in STEAM-integrated PjBL learning is to determine basic questions that can give students assignments in the form of projects to solve problems and carry out activities. The topics used must be in accordance with real-world situations.

### **The influence of the PjBL STEAM learning model on cognitive learning outcomes, creative thinking and critical thinking of junior high school students in Tanimbar Islands Regency.**

The results of the study showed that hypothesis 1 was accepted, which means that there is an influence of the PjBL STEAM learning model on the cognitive learning outcomes, creative thinking and critical thinking of junior high school students in Tanimbar Islands Regency with a sig value <0.05.

In this study, researchers conducted initial and final tests on students. The initial test was given with the aim of determining the level of mastery of students' initial concepts of ecology and biodiversity material and was useful for determining whether students had prepared themselves before participating in the learning process (Kadir, 2015). While the final test ( *post-test* ) aimed to determine the level of success both in terms of teachers and students. The final test was given to students when students had gone through a learning process to determine whether students were truly capable and complete in studying the objectives of learning ecology and biodiversity after or after the learning process was completed in one meeting.

Based on the results of the final stage data analysis contained in the pre-test and post-test results. The results obtained indicate that the use of the PjBL - STEAM learning model at Junior High School 1 Tanimbar Selatan, shows that the average pre-test and post-test scores are higher compared to Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara. Furthermore, it is strengthened by statistical analysis using ANCOVA analysis at Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara showing that there is an influence of the PjBL STEAM learning model on cognitive learning outcomes, creative thinking and critical thinking (Table 4.13)

PjBL learning is a thinking activity that can improve high-level thinking skills (Rahayu et al. 2017). The PjBL learning model has advantages in improving learning habits and motivating students to think originally in solving problems in real life. And PjBL can improve students' creative thinking skills (Nita and Irwandi, 2021). Thus, project-based learning (PjBL) is ideal in realizing the goals of 21st century education because it is contextual, so it can empower students' critical and creative thinking skills. The PjBL model has also been reported to be influential in improving students' critical thinking skills (Hikmah et al. 2016; Insyasiska et al. 2017; Jamaludin, 2018).

The STEAM approach to the PjBL learning process, teachers provide guidance in the form of observing, asking, trying, associating, and communicating a natural phenomenon that students usually experience in everyday life. Furthermore, students are able to develop their creative thinking skills by identifying possible alternative answers found. The next stage, students find solutions to a problem, will create miniature technology and are able to take steps to implement solutions to a problem. The next stage, students design and create products according to the planned steps called art. At this art stage, students design projects according to the problems given by the teacher. The project design stage will bring out and hone students' creativity. At the end of the student stage, the teacher guides students to be able to make models. Priantari, (2020) stated that STEAM integrated project-based learning emphasizes student activities and cognitive constructivism. Students' learning experiences and concepts are built based on the products produced in the project-based learning process where students constructively deepen their learning with a research-based approach to problem topics (Grant, 2002).



Learning with the STEAM approach can hone and develop students' skills, such as being able to express ideas and become more creative, with this STEAM approach students appear more active and can channel ideas and be more creative (Hidayani, 2017).

So it can be concluded that there are differences in learning outcomes, creative thinking and critical thinking of students who are taught with the PjBL - STEAM learning model with ecology and biodiversity materials. Developing learning outcomes, creative thinking and critical thinking of students about learning is basically helping students see the relationship between the material being studied and themselves and if students see that the results of their learning experiences will bring progress to themselves, then it is likely that students will be motivated in learning so that the results of their learning efforts can increase.

### **The Influence of the PBL STEAM Learning Model on Cognitive Learning Outcomes, Creative Thinking and Critical Thinking of Junior High School Students in Tanimbar Islands Regency.**

The results of the study indicate that hypothesis 2 can be accepted, because the results of the study show that the influence of the PBL STEAM learning model on the cognitive learning outcomes, creative thinking and critical thinking of junior high school students in Tanimbar Islands Regency has a sig value  $<0.05$ .

Based on the results of the final stage data analysis contained in the pre-test and post-test results. The results obtained indicate that the use of the PBL-STEAM learning model at Junior High School 1 Tanimbar Selatan, shows that the average pre-test and post-test scores are higher compared to Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara. Furthermore, it is strengthened by statistical analysis using ANCOVA analysis at Junior High School 1 Tanimbar Selatan, Junior High School 2 Tanimbar Selatan and Junior High School 1 Tanimbar Utara, showing that there is an influence of the PBL STEAM learning model on cognitive learning outcomes, creative thinking and critical thinking.

The effect of implementing the STEAM-based PBL learning model on students' cognitive, creative and critical thinking learning outcomes can also be seen from the average Pretest and Posttest scores which show that there is an effect after being given learning using the STEAM-based PBL learning model on the cognitive, creative and critical thinking learning outcomes of junior high school students in Tanimbar, based on the analysis of the question criteria it is known that the questions are able to improve students' cognitive, creative and critical thinking learning outcomes to be better, after being given the use of the STEAM PBL learning model.

There are differences in learning outcomes, creative thinking and critical thinking between the two classes due to several things, first, students have higher learning motivation. Because in class students discuss and can exchange ideas in achieving the desired goals and targets by using the PBL - STEAM learning model, so that it can attract students' attention to other groups. In the learning process, students look very serious in combining opinions, finding sources of material and summarizing them, and expressing their ideas. This condition is in accordance with the opinion of Aunurrahman (2012) in his book which states that "students who have motivation will be seen through actively asking questions, expressing opinions, concluding learning, taking notes, making resumes, practicing something, doing exercises and conducting evaluations according to learning guidelines".

Students who are treated using the PBL learning model find it easier to understand the material, especially in this study, namely the material on ecology and biodiversity. In addition, students also tend to be more active and enthusiastic in PBL learning activities (Faizah et al. 2024). This is different from students who are treated using conventional learning models, students are less able to remember the material given and students tend to be passive in learning activities, only a few students are active.

The use of PBL learning models with conventional learning models certainly has an impact on students' learning outcomes, creative thinking and critical thinking. From this explanation, the learning outcomes, creative thinking and critical thinking of students who use the PBL learning model are better than the learning outcomes of students who use conventional learning models. PBL is learning that uses real, unstructured and open problems as a context for students to develop problem-solving and critical thinking skills and build new knowledge (Savery, 2015; Sinambela and Setiawan, 2023). By solving these problems, students build knowledge and at the same time develop critical thinking skills and problem-solving skills.

PBL requires students to be able to develop problem-solving skills to achieve solutions. Provide motivation and develop thinking skills through the exchange of opinions and various discoveries. Provide a sense of responsibility to students in forming and implementing them directly in the learning process, requiring students to be able to provide examples of problems so that they can be discussed together in small groups to find common solutions (Nadhirah and Yanti, 2020; Sinambela and Setiawan, 2023).

In principle, PBL emphasizes on improving and improving learning methods with the aim of strengthening concepts in real situations, developing high-level thinking skills, problem-solving skills, increasing student learning activities, developing decision-making skills, exploring information, increasing self-confidence, responsibility, cooperation, and communication. The learning process with the PBL model greatly supports the development of

skills in independence, collaboration, high-level thinking skills including creative thinking, the ability to explore information which are all needed in the world of work (Tan, 2009).

So it can be concluded that there are differences in learning outcomes, creative thinking and critical thinking of students who are taught with the PBL - STEAM learning model with ecology and biodiversity materials. Developing learning outcomes, creative thinking and critical thinking of students towards learning is basically helping students see the relationship between the material being studied and themselves and if students see that the results of their learning experiences will bring progress to themselves then it is likely that students will be motivated in learning so that the results of their learning efforts can increase.

## CONCLUSION

Based on the research results that have been described, it can be concluded that there is an influence of the PjBL STEAM learning model on the cognitive learning outcomes, creative thinking and critical thinking of junior high school students in the Tanimbar Islands Regency with a sig value  $<0.05$  and there is also an influence of the PBL STEAM learning model on the cognitive learning outcomes, creative thinking and critical thinking of junior high school students in the Tanimbar Islands Regency with a sig value  $<0.05$ .

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