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Comparison of students' critical thinking ability between PBL and PjBL learning groups on environmental pollution material Phase-E at SMAN 1 2x11 Kayu Tanam

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Abstract

21st century learning prepares high school graduates to master critical thinking ability. However, there are still many high school graduates who do not have critical thinking ability. One way to overcome students' low critical thinking ability is to use innovative learning models that prioritize student activity. This research aims to compare the critical thinking abilities of students taught using the Problem-based learning (PBL) and Project-based learning (Pj.BL) models. This study uses a posttest-only control group design and is quasi-experimental in nature. Determination of the sample through the use of a purposive sampling technique. The data obtained is in the form of data resulting from critical thinking ability. The instrument used is a critical thinking ability test instrument in the form of a description test. The data analysis techniques used are normality, homogeneity and hypothesis testing at a significance level (α) = 0.05. Based on data analysis, the results obtained are t_{count} = 4.552 > t_{table} = 1.998 which states that H_1 is accepted. Based on these results, it can be concluded that the Problem-based learning model is more effective than the Project-based learning model in honing students' critical thinking ability.

Kata kunci: critical thinking ability; problem-based learning; project-based learning

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INTRODUCTION

The Industrial Revolution Era 4.0 has entered the world of education today. Human life in the 21st The "century of openness" refers to this century. or the "century of globalization" and the previous century have experienced fundamental and diverse changes. Rapid developments in science and technology mark twenty-first century learning. During the industrial revolution 4.0, machines replaced humans in many jobs. With the development of technology, human lifestyles have changed (Wijaya et al., 2016).

In this 21st century learning era, educational institutions are required to hone the ability to think creatively, the the capacity to solve issues and think critically, the capacity to communicate and collaborate or known as 4C (Zubaidah, 2016). The availability of human resources who are able to think critically is one of the important agendas in modern education today is so that trained human resources can develop and compete in global challenges.

Currently educational institutions in Indonesia are already using the independent curriculum, although it has not yet been implemented in all educational institutions in Indonesia. The independent curriculum is a curriculum with diverse learning and focuses on essential material so that students can undesrstand concepts and strengthen their competencies in sufficient (Khoirurrijal et al., 2022). This curriculum change was carried out in order to respond to global challenges. Only those who master the competencies will be successful in this era.

In order to raise the standard of human resources through education, educators must accustom their students to think criticalcally in every lesson. Critical thinking ability is a thinking activity with thw aim of making a reasonable decision about everything that is done and believed (Ennis, 2011). If students can master critical thinking ability, they will find it easier and more confident to face and solve problems that occur, both in social and individual life (Prasetiyo & Rosy, 2021).

However, students' critical thinking abilities are still very low. This is proven based on observations made at SMAN 1 2x11 Kayu Tanam on the average score for each indicator of critical thinking ability for all Phase E students of 30% on measurement material in scientific work which is in the very poor category. Many students are still less active during learning, are still focused on the teacher, students seem bored quickly, and tend to be lazy about studying. The results of interviews with physics teachers at SMAN 1 2x11 Kayu Tanam also show that the model is the traditional learning model most often used by teachers. This model involves the teacher giving an explanation and students listening. This model is considered to play less of a role in improving students' the capacity for critical thought (Islamiah et al., 2018).

The solution is to use innovative learning models as an effort to enhance one's capacity for critical thought ability. One learning model that is able to hone students' critical thinking ability is a learning model in which there are problems that must be solved or solved so that Students are actively engaged in education, like issue and project-based learning models (Dahri, 2021).

The critical thinking abilities of students can be enhanced via the problem-based learning methodology (Mareti & Hadiyanti, 2021). The model of problem-based learning uses contextual problems to encourage students' curiosity so that students are motivated to seek information to solve the problem. This problem solving process helps students increase their knowledge and develop students' critical thinking abilities (Hartati & Sholihin, 2015). This model was chosen due to the fact that the problem-based learning approach is quite good at improving students' ability to think critically abilities compared to conventional models (Al-Fikry et al., 2018).

In additionthe model of Project-based learning fosters critical thinking in pupils. through 3 main stages, namely planning, implementation and evaluation (Fitriani et al., 2019). The focus of the project-based learning paradigm is on the students and instructors as facilitators or motivators, where students produce a project/work in learning (Wijanarko et al., 2017). This model is also an option because students' critical thinking abilities increase after students study physics using a project-based learning model (Sumardiana et al., 2019).

Based on the background that has been stated, Researchers are interested conducting research with the title Comparison of Students' Critical Thinking Abilities between PBL and Pj.BL Learning Groups in Phase-E of SMAN 1 2x11 Kayu Tanam. By using these two learning models, researchers will be able to show that one of the the best teaching strategies for enhancing critical thinking abilities in the E-stage of SMAN 1 2x11 Tree Planting will be the best.

METHOD

This research is a quasi-experimental type and uses quantitative methods All students of class X phase-E of SMAN 1 2x11 Kayu Tanam are the subjects of this research who enrolled during the 2024-2025 school year's even semester. The sample used was purposive sampling. Two experimental classes-class 1 using a problem-based learning model and class 2 using a project-based learning model-were used for the post-test control group design only. After being treated with different learning models, both groups will be given a final test to find out which learning model is most effective in honing the critical thinking ability of each group. The design of this research can be seen in Table 1.

Table 1. Posttest Only Control Group Design

Group	Treatment	Test
Experimental class 1	X_1	T
Experimental class 2	X_2	T

Source: (Sugiyono, 2013)

Where X_1 is Learning that uses a problem-based learning model, X_1 is Learning that uses a project-based learning model and T is Posttest.

The instrument used in this research wa s critical thinking ability test on enviromental pollution material. The instrument is in the form of a description test consisting of 16 questions which were developed based on 5 indicators of critical thinking abilities according to Ennis (2011). Students' critical thinking abilities can be grouped into five categories according to Srianty (2016) which can be seen in Table 2.

Table 2. Critical Thinking Ability Category

Critical thinking ability percentage interval	Category
0 - 39	Very less
40 - 55	Not enough
56 - 65	Enough
66 - 79	Good
80 - 100	Very well

Source: (Srianty et al., 2016)

For technical data analysis, there are prerequisite tests consisting of a normality test using the liliefors equation, a homogeneity test using the variance test or F-test with a significance level of 5%, and hypothesis testing using the independent t-test.

RESULTS AND DISCUSSION

Research Result

The data that will be described from this research is data on students' critical thinking abilities as seen from the final research test which is assessed in accordance with critical thinking abilities in PBL and Pj.BL classes. Research data was obtained from tests completed at the conclusion of the study using written test techniques as prompts for essays. These results were obtained and Experimental classes 1 and 2 employed the PBL and Pj.BL models, respectively. model which was analyzed according to measures of critical thinking abilities to see the differences in the two learning approaches' effects on

critical thinking skills Data from the description of the results of critical thinking abilities in environmental pollution using the PBL model can be seen in Table 2.

Table 2. Description of the Results of the PBL Group's Critical Thinking Ability

No	Indicators of critical thinking abilities that are measured	Average value (%)	Category
1	Focusing questions	81	Very well
2	Analyze arguments	76	Good
3	Ask and answer questions	94	Very well
4	Consider whether the source is trustworthy or not	76	Good
5	Make an induction and consider the results of the induction	82	Very well
6	Make deductions and consider the results of the deduction	79	Good
7	Make and consider value decisions	85	Very well
8	Define terms and consider definitions	81	Very well
9	Identify assumptions	91	Very well
10	Determining an action	88	Very well
11	Interact with other people	80	Very well
	Average	**83%**	**Very well**

Table 2 demonstrates that the indicator of concentrating on questions received an 81% score in the very well category, the indicator of analyzing arguments received a 76% score in the good category, the indicator of posing and responding to questions received a 94% score in the very well category, the indicator of evaluating the reliability of the source received a 76% score in the good category, the indicator of conducting an induction and taking the results into consideration received an 82% score in the very well category, and the indicator of making deductions and taking the deductions' results received a 79% score in the good category was found to be in the good category; an indicator of defining terms and taking definitions into consideration was found to be in the very well category with a score of 85%; an indicator of identifying assumptions was found to be in the very well category with a score of 91%; an indicator of choosing an action was found to be in the very well category with a score of 88%; and an indicator of interacting with others was found to be in the very well category with a score of 80%.

Table 3. Description of the Results of the Pj.BL Group's Critical Thinking Ability

No	Indicators of critical thinking abilities that are measured	Average value (%)	Category
1	Focusing questions	68	Good
2	Analyze arguments	68	Good
3	Ask and answer questions	91	Very well
4	Consider whether the source is trustworthy or not	71	Good
5	Make an induction and consider the results of the induction	76	Good

No	Indicators of critical thinking abilities that are measured	Average value (%)	Category
6	Make deductions and consider the results of the deduction	73	Good
7	Make and consider value decisions	77	Good
8	Define terms and consider definitions	77	Good
9	Identify assumptions	79	Good
10	Determining an action	77	Good
11	Interact with other people	83	Very well
	Average	**76%**	**Good**

Table 3 indicates that the indicator focusing on questions answered correctly yielded a score of 68% in the appropriate category; the indicator analyzing answers correctly yielded a score of 68% in the appropriate category; and the indicator asking questions correctly yielded a score of 91%. In the category with high accuracy, the indicator measures source that can be either fully or partially attributed to a score of 71%. In the category with high accuracy, the indicator measures the amount of induction that is attributed to a score of 76%. It falls into the "good" category, with an indicator that measures motor activity and improves motor performance yielding a score of almost 73% for the "good" category., Indicators that take and consider the value of decisions get a score of 77 percent in the good category, indicators that define terms and consider their definitions get a score of 77 percent in the good category, indicators that identify assumptions get a score of 79 percent in the good category, indicators that define actions got a score of 77 percent in the good category, and indicators related to other people got a score of 77 percent in the good category.

Based on the scores obtained between the students' initial and final scores, there was an increase in the average student scores before and after the research. A comparison of the increase in value can be seen in Figure 1.

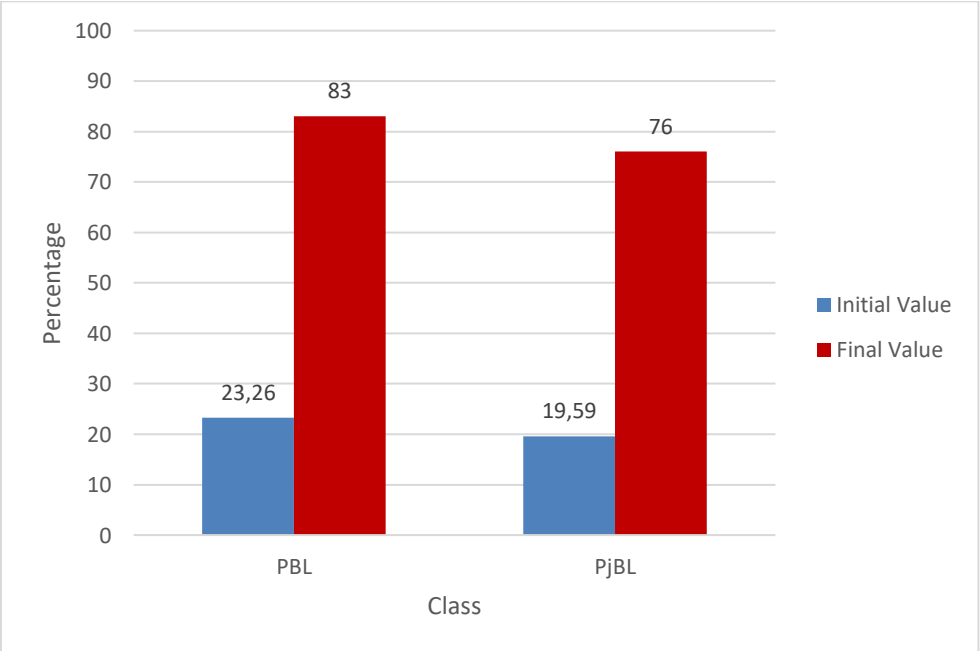

Figure 1. Comparison of the increase in the initial and final average scores of the two sample classes

Figure 1 shows that in the PBL group the average student score before the experiment was 23,26% and after the experiment was 83%. Meanwhile, in the Pj.BL group the average score before the experiment was 19,58% and after the experiment was 76%. Therefore, it may be said that a problem-based learning approach was employed in the first experimental clas more effectively for honing students' critical thinking ability than experimental class 2 which uses a project-based learning model.

Normality test

The results of the normality test carried out obtained the Lcount and Ltable values at a real level of 0.05 which can be seen in Table 4.

Table 4. Normality Test Results for Critical Thinking Abilities of the Two Sample Classes

Class	α	N	L_0	L_t	Distribution
PBL	0,05	33	0,144	0,154	Normal
Pj.BL		32	0,151	0,156	Normal

Table 4 shows that the critical thinking abilities of students in both sample classes are normally distributed. It is shown that both sample classes have $L_{count} < L_{table}$ at a significance level of 0.05, namely experimental class 1 (0,144 < 0,154) and experimental class 2 (0,151 < 0,156).

Homogeneity test

The F test in the homogeneity test was used and after calculations were carried out on the homogeneity test results, and the two sample classes for critical thinking abilities of the two sample classes were obtained which can be seen in Table 5.

Table 5. Test Results for the Homogeneity of Critical Thinking Abilities of the Two Sample Classes

Class	N	α	S^2	F_{count}	F_{table}	Information
PBL	33	0,05	32,92	1,793	1,84	Homogen
Pj.BL	32		59,03			

Table 5 shows that the results of the homogeneity of variance test carried out on the critical thinking ability data for the two sample classes showed that F_{count} = 1.793 and F_{table} = 1.84 with α = 0.05 in the $dk_{numerator}$ 31 and the $dk_{denominator}$ 32 being 1.84. The calculation results show that Fh < Ft (0.05)(31:32), this shows that the two sample classes have homogeneous variances.

Hypothesis testing

Normality and homogeneity tests allow if both sample classes have a normal distribution and come from a population with homogeneous variance. Therefore, a statistical test, namely the t test, can be carried out. Table 6 shows the critical thinking abilities of the two sample classes.

Table 6. Hypothesis Test Results for Critical Thinking Ability in Both Sample Classes

Class	N	α	S^2	t_{count}	t_{table}
PBL	33	0,05	32,92	4,55	1,998
Pj.BL	32		59,03		

Table 6 shows that the tcount = 4.55 and ttable = 1.998. The criteria for accepting H1 if (tcount > ttable) Figure 2 illustrates that in this investigation, tcount is bigger than ttable, specifically (4.55 > 1.998).

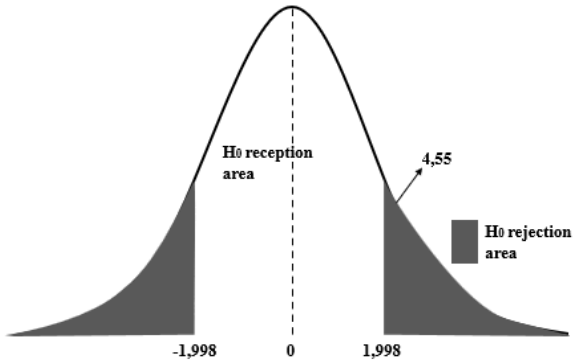

Figure 2. Hypothesis testing area curve

Based on the curve image above, it shows that tcount is in the H0 rejection area, namely -ttable < tcount < ttable, meaning that H1 is approved whereas H0 is refused. So, the hypothesis test's findings indicate the existence of a learning model. that is most effective in honing the critical thinking abilities of Phase E students at SMAN 1 2x11 Kayu Tanam utilizing the learning models PBL and Pj.BL.

Discussion

The research results show that In SMAN 1 2x11 Phase E The problem-based learning approach and students' capacity for critical thought (PBL) outperforms the project-based learning model (Pj.BL). Tanam Kayu on environmental pollution material. This conclusion was obtained from the average value of critical thinking abilities obtained from each indicator in the two models. Within the framework of problem-based learning, the capacity for critical thought of pupils average 83%. whereas it was 76% in the project-based learning experimental class 2. This is according to a study conducted by (Parno et al., 2019; Permata et al., 2018; Yance et al., 2013) which declares that the application of PBL and Pj.BL learning models has a greater effect in improving thinking skills. students' critical thinking compared to using Pj.BL models.

Experimental class 1 shows very good results when the problem-based model is applied. Students look more anthusiastic, more active and more interested in environmental pollution material. When the problem-based model is applied, students can work together with their teams to solve the problems given. In contrast to experimental class 2 which used a project-based model, many students were lazy and did not contribute enough to group work, so that the planned projects were not completed well. Many students do not understand the concept of environmental pollution. Therefore, the posttest results from both classes show that experimental class 1 used the problem-based model (PBL) more effectively in improving critical thinking ability compared to using the project-based model (Pj.BL).

Both learning models have been proven to strengthen students' capacity for critical thought. This is because the two models applied are both given issues or issues that come up in daily life, namely regarding environmental pollution. In experimental class 1, the model of problem-based learning (PBL) was implemented. In PBL learning, students are given real problems and organized into teams/groups. From the problem given Students should be able to locate at the start of the class the core of the issue and consider how to resolve it (Haerullah & Hasan, 2017). Through heterogeneous group members, students exchange ideas and work together in solving problems, so that through group discussion activities they can train students' critical thinking abilities (Setyorini et al., 2011).

Experimental class 2 applied the Pj.BL model or project-based learning, students learn to plan and build real problems which are worked on in groups so that relationships are established between students, work together, and are mutually responsible in carrying out their respective tasks to produce quality products (Permata et al., 2018). By making projects, students can be more active in exploring various information so that students gain new knowledge and learning becomes more meaningful. These two learning models can both improve critical thinking ability with their respective advantages, but judging from the average critical thinking ability score of students from each indicator, learning using the PBL model is superior to using the Pj.BL model.

Critical thinking ability has 12 indicators (Ennis, 2011). However, this study only used 11 markers of critical thinking skills. Each indicator is analyzed based on the average value obtained from the two experimental classes. The first indicator is focusing questionsThe first experimental class that uses the PBL model has a better category than the second experimental class that uses the Pj.BL model model which has a good category in critical thinking abilities. This is based on the characteristics of the PBL model which poses challenges when learning first, therefore that it can trigger students' curiosity, so that it can become a place for students to explore the world around them (Sulardi et al., 2017). Next, referring to a problem, students are trained to answer questions that require explanation, this is in accordance with the steps in problem solving, namely identifying and analyzing problems (Yu et al., 2015). So, in the PBL model, students in focusing on questions are superior to students who were treated with the Pj.BL model.

The second indicator is analyzing arguments, students' critical thinking ability scores are higher The PBL model is utilized in contrast to the Pj.BL model. This is because the PBL model can encourage students to think, work, be critical and reflective, students do not immediately come to conclusions but students try to find facts and the basis for their arguments, so that with this students do not just know but also think (Amir, 2016). Thus, in terms of analyzing arguments, the PBL model is better at honing critical thinking abilities than the Pj.BL model. This is in accordance given the features of the PBL model where students are accustomed to finding hypotheses based on reality in students' daily lives, so students are more careful in conveying arguments so that they are clear with the statements presented.

The third indicator is asking and answering questions, students' critical thinking ability scores are higher using the PBL model compared to using the Pj.BL model. This is in accordance with stage 1 and stage 5 of the PBL learning model, where the issue is brought up at the start of the class. so that it triggers students' curiosity. After the discussion, students are asked to answer the problem posed at the beginning of the lesson.

The fourth indicator is considering whether the source is trustworthy or not, The value of students' The PBL model is more conducive to critical thinking than the Pj.BL model. This is consistent with the fourth phase in the PBL learning model, namely developing and presenting work. In this phase, through experiments students must analyze data by comparing the results of the experiment with existing theory (Parno et al., 2019).

In the sixth indicator, namely making deductions and taking into account the outcomes of deductions, using the PBL model, students' critical thinking abilities are higher than using the Pj.BL model. This is in accordance with the second stage in the PBL model, namely arranging pupils for education. Currently, students are asked to formulate many alternative hypotheses to make feasible decisions, whereas the Pj.BL model involves students' activeness in solving problems in completing a project.

The seventh indicator is making and considering decisions, students' critical thinking ability scores are higher using the PBL model than the Pj.BL model. This is in accordance with the fifth stage in the PBL model, namely examining and assessing the process of solving problems. When The instructor

explains the subject matter and the students have finished conducting the experiment, the students are trained to make a decision in the form of an example question that refers to indicators of critical thinking abilities.

When compared with the Pj.BL model, the main indicator is students' better critical thinking skills using the PBL model, including defining terms and considering their definitions. Because in the PBL model, the problems and questions given to students are made complicated or complex so that they do not have definite answer, therefore students have many solutions and they often conflict between one student and another, so students can consider answers independently (Diani et al., 2016).

The ninth indicator is identifying assumptions, where the value of Compared to Pj.BL, the PBL model improves critical thinking skills. This is based on the characteristics of the PBL model, namely in learning activities, students work together to gather information, find hypotheses, and exchange information with each other to find solutions to the problems they are facing. In this situation students can compare their opinions with what they have received and learned.

In the eleventh indicator, namely interacting with other people, students' critical thinking ability scores are higher Comparing the use of the Problem-Based Learning model with the Project-Based Learning approach. This is in accordance with the characteristics of the Pj.BL model, where students are directed to solve a problem in groups, thereby creating interactions and mutually supportive relationships between students in the same group in project creation activities (Yunus et al., 2011).

Based on the overall value of the PBL and Pj.BL learning model indicators, these Students' critical thinking skills can be enhanced by two different learning methods, although the PBL model's average critical thinking abilities is higher than using the Pj.BL model. The problem-based learning model is student-focused learning where the instruction and curriculum revolve around problems structured in real-world problem situations (Arends, 2012). With problem-based learning, students can learn in teams/groups to find solutions and solve problems to gain new knowledge while also developing Critical analysis and problem-solving abilities (Sofyan et al., 2017).

CONCLUSION

Based an the research results, the t_{count} value was 4.552 and the t_{table} was 1.998. The calculated t_{count} value is greater that the t_{table}, so H_0 is rejected and H_1 is accepted. This shows that the problem-based learning (PBL) model is more effective in improving Phase-E students' critical thinking ability on environmental pollution material than using the project based learning model (Pj.BL).

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