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The Effectiveness of the Problem-Based Learning Model to Enhance Students' Critical Thinking Skills on Conservation Biology Courses

Iwan[1*], Sutiman Bambang Sumitro[2], Ibrohim[3], Fatchur Rohman[3]

[1] Department of Biology Education, Faculty of Teacher Training and Education, Universitas Papua, Manokwari, Indonesia.
[2] Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Brawijaya, Malang, Indonesia.
[3] Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang, Malang, Indonesia.

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Corresponding Author:
Iwan
b.iwan@unipa.ac.id

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Abstract: The purpose of this study is to ascertain how the problem-based learning approach affects students' critical thinking abilities in courses on conservation biology. This study design uses a non-equivalent control group in a quasi-experiment. Essay exam questions totaling 10 valid and reliable numbers served as the study's instrument. Pre-test and post-test questions were used to gather data. Descriptive statistics and inferential statistical tests, namely the covariance (ANCOVA) analysis with pretest values as variables at a significance level of 0.05%, were used to evaluate the research data. The IMB 23 SPSS program was utilized for data analysis because the data were homogeneous and regularly distributed. The findings demonstrated that, with a significance value of 0.000 < 0.05, there was a significant difference in the critical thinking abilities of students taught using the conventional model and those taught using the problem-based learning model. The conclusion is that in conservation biology classes, the problem-based learning approach helps students develop their critical thinking skills.

Keywords: Conservation biology; Problem-based learning; Students' critical thinking skills

Introduction

Among the 21st-century life skills required in higher education is the ability to think (P21, 2019). Among other factors, a person's capacity for success in life can be assessed by the way he thinks, particularly when it comes to attempting to solve the difficulties he faces (Dekker, 2020). Critical thinking abilities are a necessary life skill that help one perform well in all facets of life (P21, 2019). According to the Organization for Economic Cooperation and Development's (OECD) Program for International Student Assessment (PISA), Indonesian high school students' capacity for critical and creative thought was ranked 39th out of 41 countries in 2009, 63rd out of 64 countries in 2012, and 60th out of 65 countries in 2015 (OECD, 2016). One of the abilities that everyone in the twenty-first century needs to have is critical thinking (Saputra et al., 2024; Zorlu & Zorlu, 2021; Maryani et al., 2021).

To successfully solve a situation, critical thinking skills are focused on making rational, reasonable, reflective, responsible, skillful, and focused decisions (Ennis, 1993). The ability to make reasonable judgments to evaluate the quality of things, from the most basic actions to concluding claims, ideas, and arguments, is another definition of critical thinking (Beyer, 1995). According to Ennis (1993), critical thinking is described as reflective and logical thinking that focuses on believing and practicing; what is thought and practiced here includes practical tasks like asking questions,

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looking for alternatives, developing hypotheses, and planning experiments. Furthermore, critical thinking is the process of analyzing, evaluating, and rearranging one's views about a topic, piece of information, or issue, according to Paul et al. (2005). Walker (2005) describes critical thinking as a quick process of developing concepts, applying them, analyzing them, synthesizing them, and assessing data gleaned from observation, experience, and reflection.

In higher education, students can hone their critical thinking abilities. This approach aims to equip students to address global challenges of the twenty-first century (ŽivkoviĿ, 2016). Special abilities, such as critical thinking, must be taught to equip future generations to handle challenges (Rahdar et al., 2018). According to Dehghayedi et al. (2018), Students' thinking is developed and classroom conversations are facilitated by the use of critical thinking as an effective teaching strategy. In higher education, students' and instructors' learning can be substantially facilitated by cultivating critical thinking skills at the beginning of each semester.

Students will learn to develop mature thinking skills through their ability to interpret, analyze, draw conclusions from, and assess the challenges around them. Students will benefit academically in every subject by doing this. Critical thinking abilities can support students' problem-solving reasoning (Sulistyowarni et al., 2019). Students in tertiary schools must graduate with good grades and the ability to handle all personal and academic issues (Andheska et al., 2020). Therefore, In order to effectively navigate a variety of academic obstacles, students must develop their critical thinking skills (Marni et al., 2020).

However, several studies have demonstrated that critical thinking abilities still need to be utilized, such as Ulger (2018) study, which claims that students' critical thinking abilities have had little to no impact. Understanding critical thinking and how to foster it is still quite restricted, and future biology teachers' students still need to improve their critical thinking abilities (Fitriani et al., 2018). The teaching of critical thinking is a significant, unresolved educational issue (Kuhn & Dean, 2004). Students might be encouraged to enhance the critical thinking abilities of future instructors by providing issues during the process of learning (Haviz et al., 2020).

Therefore, it is necessary to plan instruction to foster the development of students' critical thinking skills as the primary objective of education (Larsson, 2017). Critical thinking abilities should be taught at all educational levels because they are crucial to human maturation and valuable intellectual asset. Critical thinking needs to be cultivated in students through practice. In order to solve a problem, one must first ponder, analyze, assess, and develop a (Asyari et al., 2016). students' critical thinking abilities must be strengthened so that they are always prepared for the difficulties they meet. To improve their critical thinking abilities, kids must always be taught to think critically (Thompson, 2019). Critical thinking abilities in students need to be developed in schools to face various life challenges (Bashith & Amin, 2017).

There have been a number of studies about pupils' critical thinking abilities, including those asserts that critical thinking might enhance students' academic performance. Next, Bezanilla et al. (2019) argues that the development of critical thinking abilities in students can. Study carried out by Iwan et al. (2020) states that students' critical thinking skills have increased. Likewise, the results of the research by Nasution et al. (2023). Demonstrates the favorable correlation between critical thinking abilities in pupils and creative thinking abilities in college students. Critical thinking skills are necessary for kids to compete in the twenty-first century. Critical thinking abilities help people make wise decisions because anyone in the modern world may obtain information via the internet (Abdurrahman et al., 2019). Critical thinking abilities are an essential component of education. For students to be empowered in their learning, critical thinking abilities are therefore crucial (Khoiriyah et al., 2015; Ismail et al., 2018; Pu et al., 2019; Masek & Yamin, 2012; Maulidiya & Nurlaelah, 2019).

It is vital to implement learning models that align with the goals and features of learning to meet the requirement for the urgent development of student's critical thinking skills (Aiman et al., 2020). The results of research conducted by Yuliati et al. (2018) shows that the application of problem-based learning can improve students' critical thinking skills. Learning must be presented with authentic problems in everyday life (Yuliati et al., 2018). It is crucial to develop students' critical thinking skills throughout the learning process because concerns have been raised regarding their lack of critical thinking. Using problem-based learning is one way to empower people (Suryanti & Nurhuda, 2021). From elementary to secondary education, critical thinking is a higher-order thinking talent that must be developed (Bonafide et al., 2021). in order for the use of problem-based learning to enhance students' capacity for critical thought (Ibrahim et al., 2020). From elementary to secondary education, critical thinking is a higher-order thinking talent that must be developed (Saputro et al., 2020).

Consequently, Critical thinking skills can be strengthened through the use of educational methods such as the PBL paradigm. Constructivist in its roots, PBL is an effective tool for fostering students' knowledge and critical thinking skills. PBL should be incorporated into conservation biology courses to help students

become environmentally aware, active participants in preserving natural resources, and problem solvers.

Based on these issues, it is believed that a solution can be found to prevent the extinction of living species. The concepts and principles of conservation biology need to be studied, shared, and applied in daily life. In the Conservation Biology course, the PBL paradigm is utilized to support pupils in honing their critical thinking skills and foster a caring attitude toward conservation (Nikmah et al., 2019). In addition, research conducted by Schilbert et al. (2023) reveals that biodiversity loss can be slowed by promoting pro-environmental behavior among students and expanding the scope of conservation education. By identifying biodiversity loss and strategies for addressing and preventing it, conservation knowledge significantly reduces species' extinction rate. Promoting conservation education among students is one action that aims to help with conservation.

It is vital to adopt PBL learning in conservation biology courses to increase biology students' critical thinking abilities because more research still needs to be done on how Students' critical thinking abilities in these classes are impacted by the PBL paradigm.

Method

Design of Research

This study falls under the category of quasi-experimental research. Pretest-Postest nonequivalent Control Group Design is the research design that Cohen et al. (2018) describe.

Tabel 1. Design of Quasi-Experimental Research

Group	Pre test	Treatment	Post test
Experiment	O1	X1	O2
Control	O3	X2	O4

Notes:
E: Experimental Group
C: Control Group
X1: Problem-Based Learning
X2: Conventional learning
O1, O3: Pre-test Score; O2, O4: Post-test score

Participants

Students enrolled in the Conservation Biology course of the VII Semester Biology Education Study Program participated in this study. The 48 participants in the sample that the researchers used for this study were divided into 2 groups: The experimental group was created from a student group that used the PBL learning approach and included twenty-four students. 24 students made up the control group, which was selected by the lecture technique.

Instrument and Data Collection

Ten items in the form of essay questions served as the instrument. The critical thinking skills tool was created with reference to Zubaidah et al. (2015), modified by Ennis (1993). The instrument for critical thinking skills that have been developed is stated to be very valid by experts at 89.17% (Very Valid). The reliability test for critical thinking skills shows Cronbach's Alpha of 0.695, which means that the reliability criteria are in the high category. Furthermore, data were collected by giving test questions to students through pretest and posttest.

Information Analysis

The research data were analyzed using descriptive statistics and inferential statistical tests, such as analysis of covariance (ANCOVA) with pretest values as covariates at a significance level of 0.05%. Prior to the Anacova analysis, tests were performed to ensure homogeneity and normality. The normality test is performed using the One-Sample Kolmogorov-Smirnov test. One way to test for homogeneity is via Levene's Test of Equality of Error Variances. Statistical evaluation with Windows' SPSS 23.0.

Result and Discussion

In the Conservation Biology course, PBL examines students' critical thinking abilities. Students taking conservation biology courses benefit from PBL because it encourages them to use their imagination and communicate their opinions and thoughts through logical arguments.

This helps PBL in this conservation field help students strengthen their critical thinking abilities. Table 1 displays the outcomes of assessments of critical thinking abilities conducted in the experimental and control classes utilizing the problem-based learning paradigm.

Table 2. The Results of the Critical Thinking Skills Test for the Experimental Class and the Control Class

Aspect	Class A (Experiment)		Class B (Control)	
	Pre-test	Post-Test	Pre-test	Post-Test
Amount of data	24	24	24	24
Lowest score	51.99	61.97	54.05	54.65
Highest score	74.79	87.91	70.52	76.86
Means	61.25	75.16	61.28	66.21

Based on Table 2 the critical thinking skills of 24 students obtained the highest posttest score for the experimental class was 87.91, and the lowest score was 61.97, with an average of 75.16. While the posttest critical thinking skills in the control class (lecture method), the

highest score was 76.86, and the lowest was 54.65, with an average value of 66.21.

Table 3. Results of the Critical Thinking Skills Normality Test

Component		Critical Thinking Pretest	Critical Thinking Posttest
N		48	48
Normal Parameters[a]	Mean	61.2709	70.6889
	Std. Deviation	5.72131	8.01628
Most Extreme Differences	Absolute	.114	.121
	Positive	.085	.121
	Negative	-.114	-.114
Kolmogorov-Smirnov Z		.792	.838
Asymp. Sig. (2-tailed)		.557	.484

a. Test distribution is Normal.

Based on Table 3 shows the pre-test value of critical thinking skills in the experimental class obtained Sig. (2-tailed) 0.557 > 0.05 so that the data is normally distributed.

Table 4. Homogeneity Test Results for Critical Thinking Skills

Levene Statistic	df1	df2	Sig.
.901	1	46	.347
.081	1	46	.778

Based on Table 4, it shows the pretest of critical thinking skills Sig > 0.05 = 0.347 > 0.05 which means that the variance of the data is homogeneous. The results of the Anacova test for critical thinking skills can be seen in Table 5.

Table 5. Data on the Results of the Critical Thinking Skills Ancova Test

Dependent Variable: Posttest critical thinking skills					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1331.394[a]	2	665.697	17.738	.000
Intercept	671.128	1	671.128	17.882	.000
Pre_ Critical	370.011	1	370.011	9.859	.003
Class	965.334	1	965.334	25.721	.000
Error	1688.865	45	37.530		
Total	242872.757	48			
Corrected Total	3020.258	47			

a. R Squared = .441 (Adjusted R Squared = .416)

Based on the results of the Anakova test, seen from the PBL learning model, it shows a probability value 0.000, which is less than 0.05 (p <0.05).

Table 6. Average Increase in Critical Thinking Skills

Class	Average Pretest	Average Posttest	Average Corrected	Enhance-ment (%)	Notation LSD
Experimental	61.25	75.16	75.17	22.71	a
Control	61.29	66.21	66.20	8.03	b

Based on Table 6, it was found that there was an increase in students' critical thinking skills in the experimental class and the control class.

Discussion

According to the Ancova test results in this study, there was a difference in the importance of students' critical thinking abilities between those who took the conservation biology course using the problem-based learning model (experimental class) and those who took it conventionally (control class). This is because PBL learning is a type of instruction that presents students with real-world situations and requires active problem-solving participation (Fadilla et al., 2021). By resolving complicated problems in small discussion groups during PBL learning, they get the chance to hone their critical thinking abilities, which will improve their capacity to recognize, assess, use logical reasoning, and interpret students (Shamdas et al., 2024; Syahfitri & Safitri, 2024).

Students can improve their critical thinking abilities in PBL learning if they actively participate in group discussion activities while working through challenges that are presented at the start of the process. Because these tasks are in line with critical thinking signs, solving these challenges demands a variety of behaviors like analyzing, evaluating, and producing (Wardani et al., 2024; Abdurrahman et al., 2019; Marni et al., 2020; Iwan et al., 2023).

The PBL approach can boost student involvement, allow them to practice their skills, foster critical thinking, and improve their ability to deal with current situations (Noris et al., 2024). Students can strengthen their critical thinking abilities as long as they actively participate in group discussion exercises while resolving issues in the case studies the lecturer presented at the start of the learning process. Because these tasks align with critical thinking, solving the case study necessitates several of them, including analyzing, evaluating, and constructing (Meisaroh & Suparno, 2024; Saputra et al., 2024).

Students' critical thinking abilities are effectively developed through the use of the PBL learning approach (Aini et al., 2019). Because PBL stresses that students must Engage in active participation in educational activities. the PBL approach can help students enhance their critical thinking abilities. This might inspire children to learn more actively and purposefully to develop strong critical thinking abilities and thoroughly

comprehend the idea (Miterianifa et al., 2019; Asyari et al., 2016; Kardoyo et al., 2020).

The lecturer is the main figure in the educational system, and typical teaching techniques are employed in the control class. Compared to the experimental class that is taught utilizing the PBL approach, students in the class under control participate in the learning less actively. Less training is given to students' critical thinking abilities due to their lack of participation in the learning. A critical thinker must be able to provide justification for his decisions and be able to respond to the issue of why a particular decision was made (Iwan et al., 2024).

The findings of this study demonstrate that students' critical thinking skills have improved as a result of the experimental class implementing the PBL learning paradigm. This instructional strategy can give pupils the chance to practice critical thinking. The PBL learning technique employs problems that students frequently meet in daily life as the initial notion of learning. The research findings are in line with the research that has been done by Irwanto et al. (2019). This study's results show that, due to the experimental class's adoption of the PBL learning paradigm, students' critical thinking abilities have increased. This instructional strategy can give pupils the chance to practice critical thinking. The PBL learning technique employs problems that students frequently meet in daily life as the initial notion of learning. Students are then urged to actively participate in solving the difficulties with their group members.

Although some children are still categorized as having limited critical thinking skills, this ability can grow effectively. Because they are still reserved and have not had the chance to overcome their shyness, it is tough for them to voice their ideas. Most students have been able to assess and identify the challenges they have run into, but some have struggled to find the best possible answers. Arens et al. (2008) supports this by stating that the PBL learning model is one in which students work on real-world problems to build their knowledge, develop higher-order thinking and inquiry skills, and gain independence and self-assurance. PBL learning is characterized by asking questions or solving issues, concentrating on interdisciplinary relationships, conducting real-world investigations, creating products and showcasing them, and collaborating. The steps in the PBL model are as follows: The instructor assigns problems to the students, They recognize the issues, look for knowledge from many sources to address the issues, They choose the most effective way to address the issues and The instructor grades the pupil's work (Macklin, 2001; Gorghiu et al., 2015; Alrahlah, 2016; Kasuga et al., 2022; Nurkhasanah & Rohaeti, 2024).

According to the findings of the learning analysis conducted for this study, PBL learning contributes more to developing critical thinking abilities than learning that relies on traditional models (lectures). The learning outcomes of pupils who employ the PBL paradigm to achieve a significant increase show its effectiveness. This is corroborated by studies by Silitonga et al. (2024) indicates improved critical thinking abilities when employing the PBL paradigm instead of the (classroom-based) lecture technique, which shows no change. In PBL learning, there is a variation in how students' critical thinking abilities are developed (Suyanti et al., 2021). Research result Wahyudiati (2022) reveals that using the PBL model considerably impacts critical thinking abilities, with a model contribution of 28%. PBL paradigm that actively engages students in presenting arguments or opinions, stating problems, practicing to induce and conclude, and carrying out assessments is necessary to enhance the critical thinking abilities of biology students (Wijanarko et al., 2024; Asyari et al., 2016).

Because PBL learning taught students how to think critically while solving real problems in groups, the experimental class's high critical thinking proficiency was a result of this (Amin et al., 2017). The PBL learning approach can help students' critical thinking abilities. Students can collaborate with the members of their relevant groups to solve difficulties. Additionally, students can speak up in front of the class, make arguments to support those viewpoints, encounter genuine issues, and participate in coming up with solutions (Kardoyo et al., 2020).

PBL enhances pupils' capacity for critical thought. PBL brings this distinction because it teaches students how to sharpen their problem-solving abilities through activities at the heart of PBL. The second, third, and fourth phases of PBL activities, which make up its core, allow students to actively construct knowledge through problem-solving activities that can cultivate critical thinking habits (Khoirulloh et al., 2024). Research result by Catur et al. (2022) this reveals that students taught using the PBL learning paradigm have different values for critical thinking skills than those taught using traditional methods. The experimental group's posttest scores, which are higher than those of the control group, demonstrate that PBL-based training improves students' capacity for critical thought (Hugerat et al., 2021; Saputra et al., 2024).

The findings from this study are also in line with research conducted by Schilbert & Scheersoi (2023) shows that conservation education should be expanded by communicating conservation topics to students and encouraging pro-environmental behavior that can reduce biodiversity loss. Conservation knowledge plays a major role in reducing species extinction by

uncovering biodiversity loss and finding ways to combat and prevent it. Likewise research conducted by Jadallah et al. (2021). Resilient socio-ecological system, it is essential to involve stakeholders, including students, in the conservation and management of natural resources (Puspitaningrum et al., 2018).

According to this research, students' social sensitivity toward coral reef conservation was influenced by their education. It is possible to define conservation as the routine upkeep and protection of something to avoid harm and extinction. Conservation education aims to instill in children a sense of responsibility for preserving the environment and guarding it from harm and extinction. Education about environmental preservation has yet to be formally incorporated into the curriculum. As a result, co-curricular education learning outside of the classroom must be used for conservation education.

Conclusion

It is possible to draw the following conclusions from the data and discussion: Students' critical thinking abilities have improved both before and after the PBL approach was implemented. There are changes in students' critical thinking abilities between classes that use the PBL model and those that utilize the conventional mode. The average value of critical thinking skills before introducing PBL was 61.25, and after implementing PBL it became 75.16 This can be seen from the significant effect of 0.000 < 0.05; PBL model can be used to increase student engagement and critical thinking skills. PBL learning can help students become more aware of problems in their environment and more receptive in finding solutions. Everyone needs to cultivate and familiarize themselves with critical thinking skills. Students will continue to practice this critical thinking until they start working. Students' critical thinking capacity will help them solve various problems they are currently facing or will face.

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Prepared the data analysis, methodology, and initial draft; S.B.S., I., and F.R. performed validation, review, and editing.

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