JPPIPA 10(7) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

The Effect of Discovery Learning Model on Concept Mastery and Critical Thinking Ability of Biology Students

Baiq Wahdini Yutama Sari[1*], A Wahab Jufri[1], Anindita SHM Kusuma[1]

[1] Biology Education Study Program, Faculty of Teacher Training and Education, Mataram University, Indonesia

Received: May 9, 2024
Revised: June 30, 2024
Accepted: July 25, 2024
Published: July 31, 2024

Corresponding Author:
Baiq Wahdini Yutama Sari
baiqwahdini@gmail.com

DOI: 10.29303/jppipa.v10i7.8455

Abstract: This study aims to analyze the effect of the application of the discovery learning model on concept mastery and critical thinking skills of biology students in class X SMA Negeri 2 Labuapi. The classes that were used as samples were first tested for equality in all X classes using a multiple choice test and then analyzed using the costat test so that class XD was obtained as the experimental class and class XA as the control class. Data collection on concept mastery used multiple choice tests while data on critical thinking skills used essay tests. Data analysis used anacova test with a significance value of concept mastery obtained of 0.001 (significant <0.05). The significance value of critical thinking ability obtained was 0.002 (significant <0.05). The results showed that 1) there is an effect of the discovery learning model on the mastery of concepts of students in class X SMA Negeri 2 Labuapi and 2) there is an effect of the discovery learning model on the critical thinking skills of students in class X SMA Negeri 2 Labuapi.

Keywords: Discovery learning; Critical thinking ability; Concept mastery

Introduction

The 2018 PISA test results showed that Indonesia scored an average of 396 in science and ranked 71 out of 79 countries. In OECD countries such as China and Singapore, 78% of students reached level 2 or higher in science, where students can recognize correct explanations for familiar scientific phenomena and can use that knowledge to identify them in simple cases. In Indonesia, the OECD explains that 35% of students are still in the level 1a competency group and 17% in the lower levels in science (OECD, 2018). These scores show that students' science skills are still low, especially in biology.

Biology is an important science as the basis for various applied sciences that are closely related to observations in the environment so that basic skills are needed that must be mastered (Prihatiningtyas et al., 2021). Biology is learned from discovery to understand the concepts and processes of science with the scientific method (Santosa, 2018). Students are expected to have the ability to master biological concepts. Concept mastery is the ability to understand and master concepts in solving problems and applying to certain events (Azizaturrizkina et al., 2021). Students can practice concept mastery by practicing problems and analyzing problems that arise during teaching. In addition to good concept mastery, students must also have higher-level thinking skills, one of which is critical thinking skills.

Students who do not have critical thinking skills cannot solve the problems that arise. In fact, critical thinking skills and concept mastery are not yet in accordance with science learning (Ramdani et al., 2020). Critical thinking is a high-level thinking ability by solving problems, studying and processing. Critical thinking is a process to analyze problems that arise so that the knowledge received is better understood (Atina, 2021). Critical thinking skills involve cognitive processes and encourage students to be reflective about problems. Students who have critical thinking skills will find a more appropriate direction in the process of thinking,

How to Cite:
Sari, B. W. Y., Jufri, A. W., & Kusuma, A. S. (2024). The Effect of Discovery Learning Model on Concept Mastery and Critical Thinking Ability of Biology Students. *Jurnal Penelitian Pendidikan IPA*, *10*(7), 4270–4277. https://doi.org/10.29303/jppipa.v10i7.8455

working and determining the relationship between one another (Saputra, 2020).

Based on the results of observations made, class X students at SMA Negeri 2 Labuapi lack concept mastery and critical thinking skills. This is evidenced by the inactivity of students during learning. Students only record what the teacher tells them without asking questions or analyzing what is recorded. Learning that is not done pleasantly will make students feel bored so that it has an impact on lack of understanding and students are unable to prove the information obtained about further biological material.

Efforts to improve the quality of education in schools related to mastery of concepts and critical thinking skills can be carried out through group discussions to increase student activeness during learning, this is in line with Prasetyo & Abduh's research (2021) which states that students are enthusiastic during group discussions, where students are able to convey their opinions on problems that arise in group discussions. One of the learning models that is expected to improve the quality of learning so that students have the ability to think critically and master concepts in learning is discovery learning.

Discovery learning is a learning process that emphasizes students to be able to organize their own learning in finding concepts by emphasizing the importance of understanding the structure or ideas of the discipline and being actively involved during learning (Fajri, 2019). By applying the discovery learning model, students are more active in learning, students have the freedom to learn in a pleasant atmosphere and feel they have the ability to discover new things, reduce fear and tension during the learning process and make students able to interact and work well together (Rizal et al., 2018). Based on this background, research with the title Effect of Discovery Learning Model on Concept Mastery and Critical Thinking Ability of Biology Class X Students of SMA Negeri 2 Labuapi needs to be done.

Method

The purpose of this study was to determine the effect of the discovery learning model on concept mastery and critical thinking skills of biology students in class X SMA Negeri 2 Labuapi. The type of research used is a quasi experiment with a nonrandomized control group design as shown in Table 1.

Table 1. Nonrandomized Control Group Research Design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O_2
Control	O_3	-	O_4

The research stages began with giving a pretest to both classes that were used as samples to measure students' initial abilities before being given treatment. Furthermore, the experimental class was given treatment using the discovery learning model and ended with a posttest to measure the final ability of students after being given treatment.

The population in this study were all students of class X SMA Negeri 2 Labuapi while the samples in this study were class XD as the experimental class and class XA as the control class. The determination of the sample was carried out with an equality test in the form of a multiple choice test. The multiple choice test was tested in all classes and then analyzed the results of the class equality test with the help of the costat application so that it would be known that the equivalent class was indicated by the same notation Kusuma (2023). This study uses multiple choice tests to measure concept mastery and essay tests to measure critical thinking skills.

Result and Discussion

The description of the average concept mastery data of the experimental and control classes is presented in Figure 1.

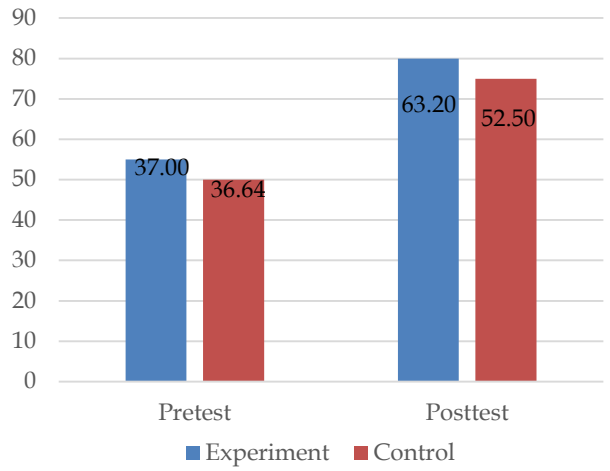

Figure 1. Comparison of Pretest and Posttest Data on Concept Mastery

Based on Figure 1, the average pretest score of the experimental class was 37.00 and the control class pretest was 36.64. While the average posttest score of the experimental class was 63.20 and the control class was 52.50. Description of the average critical thinking ability data is presented in Figure 2.

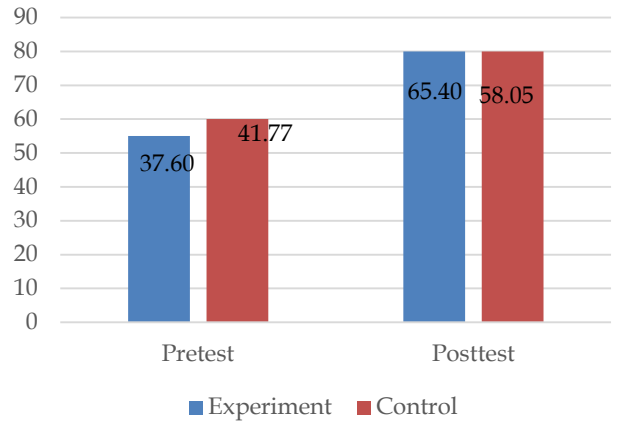

Figure 2. Comparison of Pretest and Posttest Data of Critical Thinking Ability

Based on Figure 2, the average pretest score of the experimental class was 37.60 and the control class pretest was 41.77. While the average posttest value of the experimental class was 65.40 and the control class was 58.00. Based on Figure 1 and Figure 2, it is known that the posttest value of concept mastery and critical thinking skills of the experimental class is higher than the control class.

Based on the results of the prerequisite test obtained from the pretest and posttest data of the experimental and control classes, it shows that the data is normally distributed. The normality test used is Shapiro-Wilk with the help of SPSS 21. A summary of the results of the normality test of concept mastery data is presented in Table 2.

Table 2. Summary of Normality Test Results for Concept Mastery Data

		Shapiro-Wilk		
	Class	Statistic	df	Sig.
Concept Mastery	Pretest in the experimental class	.932	25	.094
	Posttes in the experimental class	.955	25	.318
	Pretest in the control class	.931	22	.131
	Posttes in the control class	.922	22	.084

Based on Table 2, it can be seen that the significance of concept mastery data is 0.094 for the experimental class pretest, 0.131 for the control class pretest, 0.318 for the experimental class posttest, and 0.084 for the control class posttest. A summary of the normality test results for critical thinking ability data is presented in Table 3.

Table 3. Summary of Critical Thinking Ability Data Normality Test Results

		Shapiro-Wilk		
	Class	Statistic	df	Sig.
Critical Thinking Ability	Pretest in the experimental class	.947	25	.214
	Posttes in the experimental class	.936	25	.118
	Pretest in the control class	.930	22	.120
	Posttes in the control class	.952	22	.350

Based on Table 3, it is known that the significance of critical thinking ability data for the experimental class pretest is 0.214, the control class pretest is 0.120, the experimental class posttest is 0.118 and the control class posttest is 0.350. The results of the normality test that have been carried out show that the value (sig> 0.05) so that it can be said that the data is normally distributed. A summary of the results of the concept mastery data homogeneity test is presented in Table 4.

Table 4. Summary of Homogeneity Test Results for Concept Mastery Data

		Levene Statistic	df1	df2	Sig.
Concept Mastery Pretest	Based on Mean	.385	1	45	.538
	Based on Median	.364	1	45	.550
	Based on Median and with adjusted df	.364	1	44.125	.550
	Based on trimmed mean	.375	1	45	.543
Concept Mastery Posttest	Based on Mean	1.051	1	45	.311
	Based on Median	1.026	1	45	.317
	Based on Median and with adjusted df	1.026	1	44.960	.317
	Based on trimmed mean	.981	1	45	.327

Based on Table 4, it is known that the significance of the pretest test is 0.538 and the posttest is 0.543. A summary of the results of the critical thinking ability homogeneity test is presented in Table 5.

Table 5. Summary of Homogeneity Test Results for Critical Thinking Ability Data

		Levene Statistic	df1	df2	Sig.
Critical Thinking Ability Pretest	Based on Mean	.080	1	45	.779
	Based on Median	.195	1	45	.661
	Based on Median and with adjusted df	.195	1	44.194	.661
	Based on trimmed mean	.106	1	45	.747
Critical Thinking Ability Posttest	Based on Mean	3.398	1	45	.072
	Based on Median	2.317	1	45	.135
	Based on Median and with adjusted df	2.317	1	37.630	.136
	Based on trimmed mean	3.363	1	45	.073

Based on Table 5, the significance value is 0.779 for the pretest and 0.072 for the posttest. This shows that the data has the same variance (homogeneous). The last prerequisite test conducted is the linearity test. A summary of the results of the concept mastery data linearity test is presented in Table 6.

Table 6. Summary of Linearity Test Results for Concept Mastery Data

			Sum of Squares	df	Mean Square	F	Sig.
Concept Mastery Posttest * Concept Mastery Pretest	Between Groups	(Combined)	1217.356	9	135.262	.962	.486
		Linearity	667.724	1	667.724	4.748	.036
		Deviation from Linearity	549.632	8	68.704	.488	.856
	Within Groups		5203.920	37	140.646		
	Total		6421.277	46			

Based on Table 6 shows that there is a linear relationship, as evidenced by the sig value. Deviation from linearity of 0.856 > 0.05 and sig. linearity value of 0.036 < 0.005 so it can be said that there is a linear relationship between pretest and posttest data of concept mastery. A summary of the results of the critical thinking ability data linearity test is presented in Table 7.

Table 7. Summary of Linearity Test Results for Critical Thinking Ability Data

			Sum of Squares	df	Mean Square	F	Sig.
Critical Thinking Ability Posttest * Critical Thinking Ability Pretest	Between Groups	(Combined)	2269.389	13	174.568	1.733	.100
		Linearity	482.288	1	482.288	4.787	.036
		Deviation from Linearity	1787.101	12	148.925	1.478	.182
	Within Groups		3324.526	33	100.743		
	Total		5593.915	46			

Based on Table 7, the sig. deviation from linearity value is 0.182> 0.05 and the sig, linearity value is 0.036 < 0.05 so it can be said that there is a linear relationship between posttest and pretest critical thinking ability data. Based on the prerequisite tests that have been carried out that the data is normally distributed, homogeneous, linear and then hypothesis testing is carried out. The hypothesis test used is analysis of covariance (Anacova) with a significance level <0.05 then H0 is rejected and Ha is accepted. The results of hypothesis testing of concept mastery data are presented in Table 8.

Table 8. Hypothesis Test Results of Concept Mastery Data

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1964.972[a]	2	982.486	9.701	.000	.306
Intercept	3422.347	1	3422.347	33.791	.000	.434
Pretest	625.195	1	625.195	6.173	.017	.123
Strategy	1297.248	1	1297.248	12.809	.001	.225
Error	4456.305	44	101.280			
Total	165575.000	47				
Corrected Total	6421.277	46				

Based on Table 8, the hypothesis test results of concept mastery data show that the significance value is 0.001 <0.05. This shows that H0, which states that there is no effect of discovery learning model on concept mastery, is rejected and Ha, which states that there is an effect of discovery learning model on concept mastery, is accepted. In this study, the discovery learning model gives 22.5% influence on concept mastery. The corrected average of concept mastery data is presented in Table 9.

Table 9. Corrected Means of Concept Mastery Data

Class	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Ekxperiment	63.121[a]	2.013	59.064	67.178
Control	52.590[a]	2.146	48.265	56.914

Based on Table 9, the corrected average results of concept mastery data strengthen the results of hypothesis testing where the corrected average of the experimental class is greater than the control class, namely 63.121> 52.590. This means that the class that applies the discovery learning model affects the mastery of the concept of class X students of SMA Negeri 2 Labuapi. The results of the critical thinking ability data hypothesis test are presented in Table 10.

Table 10. Hypothesis Test Results of Critical Thinking Ability Data

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1487.361[a]	2	743.680	7.968	.001	.266
Intercept	3032.160	1	3032.160	32.488	.000	.425
Pretest	854.400	1	854.400	9.155	.004	.172
Strategy	1005.073	1	1005.073	10.769	.002	.197
Error	4106.554	44	93.331			
Total	186014.000	47				
Corrected Total	5593.915	46				

Based on Table 10, the hypothesis test results of critical thinking ability data show a significance value of 0.002 <0.05. This shows that H0 which states that there is no effect of discovery learning model on critical thinking ability is rejected and Ha which states that there is an effect of discovery learning model on critical thinking ability is accepted. In this study, the discovery learning model had an effect of 19.7% on critical thinking ability. The corrected mean of critical thinking ability data is presented in Table 11.

Table 11. Corrected Mean of Critical Thinking Ability Data

Class	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Experiment	66.440[a]	1.962	62.485	70.395
Control	56.864[a]	2.096	52.639	61.089

Based on Table 11, the corrected average results of critical thinking ability data strengthen the results of hypothesis testing where the corrected average of the experimental class is greater than the control class, namely 64.440> 56.864. This means that the class that applies the discovery learning model affects the critical thinking skills of students in class X SMA Negeri 2 Labuapi.

Effect of discovery learning model on concept mastery

During the learning process with the application of the discovery learning model, it shows that students play an active role in learning activities. The relationship between the application of the discovery learning model and concept mastery shows that the more optimal the teacher applies the discovery learning model, the more students' concept mastery increases. Students seemed enthusiastic and earnestly followed the directions given by the teacher. Discussion activities increase students' enthusiasm to continue learning and solving problems that arise. During the discussion, students actively exchanged opinions with their group members and sought information from various relevant sources to strengthen the opinions of each group.

The discovery learning model on concept mastery that is applied helps students to better understand the concepts in learning, this is in line with Suliyadi et al (2024), which states that discovery learning that is applied can improve concept understanding because students themselves find and solve problems in learning. Active learning in the classroom can be seen from the attitude of students during the learning process, namely with a conducive atmosphere and more

active interactions between students and teachers. This is in line with the research of Anisa et al (2021) which states that discovery learning familiarizes students to be more active, responsible for their group, have curiosity and dare to express opinions.

Discovery learning is a learning model that helps students to better remember the material because they find their own problem solving, this is in line with Cahyani & Pratiwi (2022) who suggest that discovery learning is better because it emphasizes students to investigate problems whose results will be more easily remembered by students. According to Rudibyani (2019) discovery learning has a big influence in improving students' concept mastery. The discovery learning model directs students to be actively involved during discussions, this is in line with Juwitasari (2023) who argues that discovery learning is characterized by a trait that emphasizes students on active empowerment in discussions so that students are able to work together to solve problems given by the teacher.

Group discussion which is part of the stages of the discovery learning model helps students to better master the material instead of just memorizing. Through discussion activities, students will find their own solutions to problems with their groups. Students who do learning activities with their own findings will further improve their understanding. Habsah et al. (2023) argued that students are required to explore and add learning materials through logical, critical and systematic observations so as to make students more confident in their own findings by applying the discovery learning model. Furoidah et al., (2017) discovery learning model is a model that emphasizes students to be more active in finding and identifying problems, not only receiving information explained by the teacher but students who learn to find in order to better understand the material being studied.

Effect of discovery learning model on critical thinking skills

The discovery learning model also influences students' critical thinking skills. This is in line with Dafrita (2017) who argues that discovery learning encourages students to be able to change their way of thinking and be more active in finding their own material concepts by utilizing the critical thinking skills of each student. The application of the discovery learning model begins with a problem found by students. Students must be able to identify the facts of the problem and analyze problem solving efforts with critical thinking. Discovery learning has stages that lead students to train their thinking process, starting from finding problems, identifying, collecting, processing, proving to drawing conclusions.

The application of the discovery learning model showed a difference in thinking ability between the experimental and control classes. The final score (posttest) of the experimental class was higher than the control class. This is in line with Melati et al. (2022) who argued that the critical thinking ability of the experimental class treated with discovery learning was higher than the control class. The learning process in the experimental class by applying the discovery learning model was carried out actively. The discovery learning model helps students to strengthen their self-concept so that they gain confidence in working with their group mates.

Priadi et al. (2021) argued that discovery learning can train students' critical thinking skills through discovery so that they build their own knowledge, are able to find concepts and have a longer lasting memory so that it affects their thinking skills. Aswanti & Isnaeni (2023) argued that it takes a high ability to understand the material so that it can have critical thinking skills. According to Ardhini et al., (2021) critical thinking is an important aspect that must be possessed so that students are able to choose alternative answers for themselves and are able to develop a rational attitude which can be influenced by the discovery learning model.

Critical thinking helps students to be more free to express opinions and better understand the learning material, this is in line with the opinion of Yuliati & Susianna (2023) that with critical thinking students are able to understand the material presented well in accordance with the learning objectives and are able to decide something appropriately based on information obtained through observation and discussion. With the ability to think critically, students become more active and independent because they are driven by curiosity so that self-confidence, motivation and enthusiasm for learning appear. This is in line with Nurhidayah et al. (2023) who argued that discovery learning has a good effect on improving students' critical thinking skills during learning.

Conclusion

Based on data analysis and discussion, it is known that the results of hypothesis testing of concept mastery data with a significance value of 0.001 < 0.05 and the corrected average of the experimental class is greater than the control class, namely 63.121 > 52.590 while the critical thinking ability data with a significance value of 0.002 < 0.05 and the corrected average of the experimental class is greater than the control class, namely 66.440 > 56.864, it can be concluded that the discovery learning model affects the mastery of concepts and critical thinking skills of biology class X students of SMA Negeri 2 Labuapi.

Acknowledgments
The author would like to thank the principal, teachers and students of SMA Negeri 2 Labuapi who have helped researchers until the writing of this research article is completed.

Author Contributions
This article was prepared by Baiq Wahdini Yutama Sari, A Wahab Jufri and Anindita SHM Kusuma and all members cooperated well so that this article was completed.

Funding
This research received no external funding

Conflicts of Interest
The authors declare no conflict of interest.

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