JPPIPA 8(6) (2022)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

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

The Effect of the Problem Based Learning and Double Loop Problem Solving Learning Models on Problem Solving Ability in Term of Creative Thinking on Environmental Pollution Material

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Received: August 10, 2022
Revised: November 20, 2022
Accepted: December 10, 2022
Published: December 31, 2022

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DOI: 10.29303/jppipa.v8i6.1996

Abstract: This type of research is quasi-experimental research that aims to 1) Determine the influence of problem-based learning (PBL) and Double Loop Problem Solving (DLPS) learning models on improving students' problem-solving ability. 2) Knowing the difference in the problem-solving ability of students with high creative and low creative thinking abilities. 3) Knowing the interaction of PBL and DLPS models with the ability to think creatively about problem solving. The population used in this study was grade VII students of state junior high schools in Lamongan Regency for the 2021/2022 academic year. The samples in this study consisted of 4 classes. The experimental class uses 1 PBL model for as many as two classes, and the experimental class 2 DLPS models for as many as two classes. Data collection using problem-solving ability test instruments and creative thinking test instruments. Hypothesis testing of the study using a two-way anava test with the study's results 1) There was no influence of the PBL and DLPS learning models on improving students' problem-solving ability. 2) there are differences in the problem-solving ability of students with high and low creative thinking abilities. 3) there is no interaction of the PBL and DLPS models with the ability to think creatively about students' problem-solving abilities.

Keywords: Problem-Based Learning; Double Loop Problem Solving; Creative Thinking; Problem Solving Ability

Introduction

Natural science (known with IPA) is a science that is closely related to the phenomena of the universe (Rahayu et al., 2021). Science learning involves making scientific observations and producing conclusions (Ramadhani, 2021). Science learning can review process skills, concepts, and application issues and instil curiosity in students' psyche. Science learning is expected to improve the ability to observe, understand, analyse, and solve problems to be useful for life (Oktaviani & Tari, 2018).

Science learning aims to improve students' critical thinking, creative, logical responses, and problem-solving abilities (Prastiwi, 2018). The 2013 curriculum contains the importance of problem-solving skills seen in the essential competencies of science learning; namely, students have the skills to describe concepts, natural symptoms, and principles of science so that they can be applied in solving problems in everyday life (Kementerian Pendidikan & Kebudayaan, 2016). Based on this presentation, the science learning process is expected to be able to build students' knowledge independently. The development of student knowledge alone can be done by making students the main actors of learning, making them critical, creative, and able to solve all problems encountered in science learning and its application (Oktaviani & Tari, 2018).

Problem-solving skills are considered important in science learning. Problem-solving ability is managing

How to Cite:
Permata, S.A.I., Sunarno, W., & Harlita, H. (2022). The Effect of the Problem Based Learning and Double Loop Problem Solving Learning Models on Problem Solving Ability in Term of Creative Thinking on Environmental Pollution Material. *Jurnal Penelitian Pendidikan IPA*, *8*(6), 2647–2653. https://doi.org/10.29303/jppipa.v8i6.1996

existing information and deciding what to do in a specific condition (Ramadhani, 2021). Problem-solving skills can bring students more sensitive to problems and creatively make solutions to solve problems (Supiyati et al., 2019). In life, students need problem-solving skills because students will face problems that cannot be directly found solutions to issues in the classroom and outside the school (Saputri & Febriani, 2017).

The problem-solving process requires the ability to think creatively. The ability to think creatively makes students more sensitive to problems and consider and develop the information obtained. The ability to think creatively can also familiarise students with forming new understandings by developing the knowledge they already have to be able solve the problems they are facing (Siswanto & Ratiningsih, 2020). Students with low creative thinking ability will have difficulty making ideas and analyzing problems from various points of view, thus causing a lack of problem-solving ability (Guntur et al., 2020).

The TIMSS (*Trends in International Mathematics and Science Study*) report explains that most students in Indonesia are at the second level of the six levels of *bloom taxonomy*. It indicates that the ability of students in Indonesia to think logically and rationally is still low (Sucipto, 2017). Pisa (Program for International Assessment of Student) data 2018 explains that students in Indonesia, on average, are only limited to recognizing explanations, identifying phenomena, and seeking the truth of information. Based on the results of the study shows that students' problem-solving ability is still low. According to Oktaviani & Tari (2018), one of the reasons science learning has not been said to be successful in improving students' problem-solving abilities is because the learning process focuses on grades, not revolution.

The results of interviews with several science teachers showed that students' ability to solve problems was relatively low. Students' problem-solving ability is limited to identifying and finding facts and information related to issues. Students' problem-solving abilities have not yet reached the stage of managing, analyzed data and made solutions. It happens because, during the learning process, students are less actively involved in just listening to explanations from the teacher. Students respond passively and tend to be less creative when answering questions from the teacher because students only answer questions that are in the book. Another cause is the use of underprivileged learning models to make students actively involved in the learning process less suitable for improving students' problem-solving abilities.

Based on these problems, it is necessary to carry out a science learning process that can provide opportunities for students to be more active, interactive, and able to develop creative thinking skills to improve students' abilities in problem solving. It can be done by applying a learning model that can guide and familiarize students with thinking systematically, independently and problem-solving ability. One of the effective learning methods used to improve students' problem solving skills is the PBL and DLPS learning models (Taufik et al., 2010).

PBL is a learning model that focuses on real problems to stimulate students to think critically and creativity and have the ability to solve the issues and obtain essential concepts from the material taught (Sastrawati et al., 2011). Science learning using the PBL learning model focuses on higher-order thinking. Students should trying to develop the ability to analyze and process new knowledge to help solve problems (Saputri & Febriani, 2017). Students will be allowed to find, build independently, and understand and apply concepts to solve problems faced, be it learning issues or problems in daily life (Herdiawan et al., 2019). Therefore, using the PBL learning model is to be skilled in conducting investigations, accustomed to thinking creatively and improving problem-solving ability (Saputri & Febriani, 2017). The PBL model is an effective model used for higher-order thought processes that focus on problems with the stages of orienting problems, organizing, conducting investigations, developing and presenting, analyzing and evaluating (Supiandi & Julung, 2016; Susilo et al., 2012).

DLPS is a model that focuses on finding the root of the problem, which then creates a solution to solve the Problem (Arum, 2017). The DLPS model is a model that invites students to be active directly when learning so that students can gain knowledge and get various solutions to solve problems (Nizaar & Putra, 2016). The troubleshoot process on the DLPS model is carried out with two interrelated problem-solving loops. The first loop identifies the visible cause, and the second loop the deeper cause of the problem (Jufri, 2015). The DLPS learning model emphasizes what information is collected, how to interpret data, and how to make good use of information and provides opportunities for students to acquire knowledge, experience, discover, and recognize various alternative answer solutions. (Safitri et al., 2018). Therefore, the DLPS model can familiarized students with creative thinking to improve their problem-solving ability. The DLPS learning model has six stages: identifying problems, detecting immediate causes, evaluating temporary solutions, deciding on root cause analysis, re-detecting root problems, and designing root-of-problems solutions (Jufri, 2015).

The material that is considered capable of helping students in solving problems is environmental pollution. Environmental pollution materials have various issues that can be used in the learning process. In applying the PBL and DLPS learning models, selecting environmental pollution materials will make it

easier for students to analyze and relate concepts to solve problems. It is because the problem of environmental pollution happens a lot in the student environment.

Based on the problems and descriptions above, researchers apply the PBL and DLPS learning models to improve problem-solving ability in creatively thinking in the environmental pollution material of grade VII students.

Method

This research is a quasi-experimental study with a 2 x 2 design.

Table 1. 2 x 2 Research Design (Problem Solving Ability)

Creative Thinking	PBL (X_1)	DLPS (X_2)
Low (Y_1)	$X_1 . Y_1$	$X_2 . Y_1$
High (Y_2)	$X_1 . Y_2$	$X_2 . Y_2$

Description:

$X_1 . Y_1$: Students' problem-solving ability using the PBL learning model on high creative thinking ability

$X_1 . Y_2$: Students' problem-solving ability using the PBL learning model on low creative thinking ability

$X_2 . Y_1$: Students' problem-solving ability using the DLPS learning model on high creative thinking ability

$X_2 . Y_2$: Students' problem-solving ability using the DLPS learning model on low creative thinking ability

The population in this study is grade VII students of State Junior High Schools in Lamongan Regency, knowing the lessons for 2021/2022. The samples used were students of class VII, even semester at SMPN 1 Sukodadi and SMPN 1 Sekaran, each school with as many as two classes. The sampling technique was carried out with random cluster sampling. Experimental class 1 used the PBL learning model for 49 students, and experimental class 2 used the DLPS learning model for 49 students.

In this study, the instruments applied were in the form of lesson plan and student worksheet learning models of PBL and DLPS. Meanwhile, the data collection instrument consists of a problem-solving ability test of 20 description questions and a creative thinking ability test of 6 description questions. In addition, RPP, LKS and Instruments tests have tested the contents and construct validity.

Data analysis in this study consists of a prerequisite test analysis and a hypothesis test. The prerequisite tests of the research include. 1) The normality test of Kolmogrov Smirnov. 2) Barlett homogeneity test. 3) Test the initial state of the independent t-test pretest data. Hypothesis test posttest data using a two-way anava test. Analysis prerequisite and hypothesis tests were carried out using the SPSS 26 program.

Result and Discussion

Data from the research result of students problem-solving ability. The problem-solving ability data is obtained from the posttest value. The data of the Problem-solving ability can see in Table 2.

Table 2. Creative thinking ability Data

Learning Model	Amount of Data	Average
PBL	49	72.45
DLPS	49	65.94

Creative thinking data is obtained through posttest values. The division of high and low categories is based on the average scores of the four classes. The type is low if the student's score < the average score, the high type if the student's score ≥ the grade point average. Data on creative thinking ability can be seen in Table 3.

Table 3. Creative Thinking Data on problem-solving ability

Creative Thinking	Amount of Data	Average
Low	53	62.71
High	45	78.70

From Table 3, it can be concluded that students with high creative thinking ability have a higher value of problem-solving ability. Data on students' creative thinking ability based on learning models are shown in Table 4.

Table 4. Data on Creative Thinking based on Learning Models

Learning Model	Amount of Data	Average
PBL	49	70.86
DLPS	49	65.02

The prerequisite analysis test is carried out using the pretest and posttest values to determine the data distribution. The first prerequisite analysis test is the Kolmogorov Smirnov test's normality test. The results of the normality test are shown in Table 5.

Table 5. Normality Test Results

Information	Learning Model		Sig.	Conclusion
Problem solving ability	PBL	Pretest	0.200	Normal
		Posttest	0.200	Normal
	DLPS	Pretest	0.200	Normal
		Posttest	0.200	Normal
Creative thinking ability	PBL	Pretest	0.113	Normal
		Posttest	0.078	Normal
	DLPS	Pretest	0.185	Normal
		Posttest	0.200	Normal

Table 5 shows that the significance value of the entire data is more than 0.05, so it is concluded that the whole data is normally distributed.

The second prerequisite analysis test is a homogeneity test using the *Ballet* test. The results of the homogeneity test can be seen in Table 6.

Table 6. Homogeneity Test Results

Information		Sig.	Conclusion
Problem solving ability	Pretest	0.328	Homogeneous
	Posttest	0.461	Homogeneous
Creative Thinking ability	Pretest	0.119	Homogeneous
	Posttest	0.618	Homogeneous

Table 6 shows that the significance value of the actual data is more than 0.05, so it is concluded that the complete information is homogeneous.

The third prerequisite test of the analysis is the test of the average similarity of the initial state of students through *pretest* scores using the independent t-test. The results of the Initial Average Similarity Test can be seen in Table 7.

Table 7. Student Average Early State Test Results

Description	Sig.	Information
Problem solving ability	0.323	No difference
Creative Thinking Ability	0.737	No difference

Table 7 shows that the significance value is more than 0.05, so it is concluded that there is no difference in students' initial ability before being given treatment.

Prerequisite analysis testing has been carried out, and then a hypothesis test of posttest data using anava is carried out. The results of hypothesis testing can see in Table 8.

Table 8. Hypothesis Test Results

Source	Mean	F	Sig
Corrected Model	1862.833	21.380	0.000
Intercept	448302.914	5145.235	0.000
Learning Model	270.582	3.106	0.081
Creative thinking	4.738	51.884	0.000
Model*creative thinking	87.130	0.054	0.816

Here are the conclusions of the hypothesis test results

1. The learning model has a significance value of 0.081, more significant than the significance level of 0.050, so it was concluded that there was no difference in the problem-solving ability of students who learned using the PBL and DLPS learning models.
2. The ability to think creatively has a significance value of 0.000, less than the significance level of 0.050, so it is concluded that there are differences in the problem-solving ability of students with high and low creative thinking abilities.
3. The learning and creative thinking model has a significance value of 0.816, more significant than the significance value of 0.050, so it can be concluded that there is no interaction between the PBL and DLPS learning models with the ability to think creatively towards improving students' problem-solving abilities.

Differences in Problem Solving Ability of Students Learning using PBL and DLPS Learning Models. Problem-based learning models like the PBL and DLPS can be used in an effort to improve students' problem-solving abilities. Problem-based learning allows students to observe, discover, and solve problems (Sunaryo, 2014).

Applying the PBL model can provide space for students to be active and independent in stringing knowledge. Furthermore, PBL can improve problem-solving skills because it gives problems that require students to analyze and find solutions to the problems at hand. This is in line with Budiarti & Airlanda (2019) research, confirming that the PBL model's application can provide new knowledge and improve students' ability to solve problems scientifically.

Applying the DLPS model to the learning process requires students to participate in learning actively. Students are directly involved in the research process and analyse to solve problems through 2 problem-solving loops. So that the learning process will be more meaningful and can improve problem-solving skills, and it follows the statement of Indriyani et al. (2020), which states that DLPS can improve Problem-solving skills because it provides a meaningful learning process by involving students in finding arguments and finding solutions to problems faced through 2 problem-solving loops.

In this study, from the hypothesis test results, a significance value of 0.0 81 was obtained, less than 0.05. This shows the absence of a significant influence on applying the PBL and DLPS models to problem-solving capabilities. This happens because the learning model applied is problem-based, which can improve students' problem-solving skills. So there is no difference in problem-solving ability between the two classes. However, there are still differences in the average value of problem-solving ability in the two classes. The PBL class has a higher average score of 7 2.45, and the DLPS class has a lower score of 6 5.94.

Differences in Problem Solving Ability of Students who have high and low Creative Thinking Ability. Based on the hypothesis test, it can be seen that there are differences in the problem-solving ability of students who have high and low creative thinking. The problem-solving ability of students with high creative thinking ability has a higher average score than those with low creative thinking ability. The results of the significance value calculation show a figure of 0.000, so it can be concluded that creative thinking significantly influences students' problem-solving ability. This result follows the research of Wulandary et al. (2021), which states that the

relationship between creative thinking ability and student problem-solving ability is positive and significant, with the contribution of creative thinking ability to Problem-solving ability.

The problem-solving ability of students with high creative thinking has an average score of 78.70, and the average score of students with low creative thinking ability is 62.71. Therefore, students with high creative thinking ability have higher average scores than students with low creative thinking ability. Students with high creative thinking ability will have more ideas and can apply concepts and experiences to solve problems. Students with high creative thinking ability are also accustomed to searching for information and developing the data obtained. The ability to find information and many ideas can help students analyze problems and determine solutions to problems faced. It can be seen when the learning process of students with high creative thinking skills are more active in participating in discussions and asking questions if they have difficulty finding information related to the problems faced. Students with high creative thinking ability also tend to give answers to questions with their thoughts and sentences. Guntur et al. (2020) explained the characteristics of students with high creative thinking ability: having many ideas, being able to answer questions in their own language, generating many solutions to solve problems, and having their own thoughts in solving problems.

Students with low creative thinking ability have lower average scores than students with high creative thinking ability. Students with low creative thinking ability tend to give answers by copying what they find without considering their thoughts about the problem at hand. In addition, students with low creative thinking skills provide more common solutions when solving problems. Guntur et al. (2020) mentioned that students with low creative thinking ability will have difficulty making ideas, are less able to see problems from various points of view, and are less able to express their thoughts in solving problems.

The ability to think creatively is closely related to problems, considering information and analyzing to gain new understanding by combining existing insight. The ability to think creatively can affect problem-solving ability. Students with high creative thinking ability can find information and develop information, analyzed problems, and have many ideas that can be used when implementing solutions to the problems faced.

Interaction between PBL and DLPS Learning Models with Creative Thinking on Problem Solving Ability. The application of the PBL and DLPS learning models, which are problem-based models, is able to develop students' creative thinking skills to improve their problem-solving skills. In addition, problem-based learning can provide space for students to find and apply their ideas to trained their creative thinking and problem-solving skills (Sunaryo, 2014).

The improvement of problem-solving ability occurs because the problem-based learning process involves students directly in the problem-solving process by actively seeking information, managing information, and analyzing data to solve problems. Although the problem-based learning model demands the search for solutions to the issues faced, students will be more sensitive to a problem. Therefore, they can consider and develop the information obtained. In addition, the ability to think creatively can also increase because the learning process takes place in groups which require students to express their opinions.

The PBL and DLPS learning models can improve creative thinking skills. Both models involve students actively seeking information, managing information, analyzing data and expressing ideas or ideas to solve problems. In addition, the application of the PBL and DLPS models carried out in groups can hone creative thinking skills because it requires students to express opinions with each other when discussing. This follows the opinion of Hagi & Mawardi (2021) that the PBL model can hone students' creative thinking skills, and Jufri (2015) revealed that the DLPS model could engage students to think creatively.

Students who have high creative thinking ability will have the higher problem-solving ability. This happens because students who have high creative thinking skills tend to be easy to make some solutions to the problems faced. After all, they can manage and develop the information obtained so that the solutions made are more effective. Therefore, students with high creative thinking skills during the learning process will quickly focus on facing problems and be able to make several answer choices to solve problems. The statement follows the research of Wulandary et al. (2021), which states that the relationship between creative thinking ability and student problem-solving ability is positive and significant.

The results of the hypothesis test showed a significance value of 0.816. What is interpreted is that there is no interaction between the PBL and DLPS learning models by thinking creatively about students' problem-solving abilities. The absence of interaction in this study was because many students were not used to using problem-based learning models, most students found it challenging to find information, and when the discussion took place, most students did not want to express their thoughts because they were not used to it expressing opinions can help students understand the problem more profoundly and get various points of view from the problem and ideas to solve the problem at hand. As Utomo et al. (2014) suggest, interactions with friends, such as discussing and expressing thoughts, can

train thinking broadly and review problems from many points of view.

Conclusion

Based on the study's results, it can be concluded that. There is no difference in the influence of the problem-solving ability of students who use the PBL and DLPS models. However, the average score of the problem-solving ability of PBL class students is higher than that of DLPS class. There is an influence of creative thinking on students' problem-solving ability. Students with high creative thinking ability have a higher average score of problem-solving ability. There is no interaction of the PBL and DLPS learning models with the ability to think creatively about students' problem-solving abilities. however, there was an increase in the average value of problem-solving ability after being given treatment.

Acknowledgements

The researcher would like to thank the Head of SMPN 1 Sukodadi and SMPN 1 Sekaran, science teachers, staff and all class VII students who have given permission and assistance in the research process of PBL and DLPS learning models on environmental pollution material on problem-solving ability in terms of creative thinking.

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