Conference Paper

The Effective Learning Models in Developing Problem-Solving Skills

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Abstract

21st-century learning demands and the 2013 curriculum, master problem-solving skills. Learning model that will be tested PBL, PjBL, and DL with a scientific approach. This study aims, to find out among the three learning models above, which learning model is the most effective for developing problem-solving skills. The research method used was quasi-experimental with the design of posttest-only control groups. The study population consisted of students seven classes of SMP 6 Petarukan the number is seven classes. Sample selection techniques using cluster random sampling obtained three classes for the experimental group and one for control. Data on problem-solving abilities are taken using multiple choice tests with a total of 20 item. The results showed: (1) there were no significant differences about students' ability in problem-solving taught by PBL, PjBL, and DL learning models, but differed significantly from the control group; (2) the effectiveness of the three learning models based on achievement from high to low is the PBL, PjBL, and DL models.

Keywords: discovery learning, problem-solving ability, problem-based learning, project-based learning.

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1. Introduction

Education in the 21st century is emphasized on intellectual development, to produce human resources who have contextual problem-solving abilities and have the motivation to move forward and always learn. According to Zubaidah (2016), problem-solving abilities are always related to critical thinking skills which are fundamental skills in solving problems. Learning is not only emphasized on cognitive mastery but also includes affective and psychomotor domains. Mastery of the cognitive realm is emphasized in higher-order thinking abilities including the ability to think critically and creatively for problem-solving. This is in accordance with Ellison's (2009) opinion that the ability of problem-solving is an important aspect of independent learning so that it can use its problem-solving abilities in other situations in real life.

The TIMSS results in 2015 published by the IEA, Indonesia ranked 45 of 48 with a score of 397. This is supported by the results of the 2009 PISA survey according to

the OECD (2010: 131), as many as 49.7% of Indonesian students were able to solve routine context problems still common and only 15.5% of students are able to carry out procedures and strategies in problem-solving. Meanwhile, 6.6% of students can connect problems with real life and only 2.3% of students are able to solve complex problems, are able to formulate, and communicate their findings. Thus, we can conclude that the problem-solving abilities of Indonesian students are still less than optimal. This is because in learning more students are required to master the concept and are less trained to do problem-solving. Therefore, the learning used in models innovative learning models to train students to improve their problem-solving skills. This is supported by Hung (2008) that improving students' problem-solving skills can be done by providing a variety of innovative methods and models.

The implementation of science learning according to the 2013 curriculum must use a scientific approach. According to Arends (2008), there are several learning models that support to train thinking skills and problem-solving abilities in students, namely Problem Based Learning (PBL), Project Based Learning (PjBL), and Discovery Learning (DL). Research of Priyayi et al. (2017), which implements PjBL in science learning states that the implementation of PjBL in Biology learning can improve cognitive learning outcomes and problem-solving skills. This is supported by the research of Pangaribowo et al. (2017), which concluded that the Discovery Learning model can improve student learning outcomes, train students to be skilled, active, and independent. In addition, students' curiosity about the material is so high that it will motivate students to improve learning outcomes. Therefore, the learning model based on the 2013 curriculum reference includes Problem Based Learning, Project Based Learning, and Discovery Learning is expected to be able to make students active in learning and develop students' problem-solving skills.

2. Method

The research method used was quasi-experimental with posttest-only control group design. The population in this study were class VII students of SMP Negeri 6 Petarukan 2018/2019 school year consisting of seven study groups (class). Determination of samples using cluster random sampling obtained three classes for the experimental group and one control group class. The first experimental class carried out Problem Based Learning learning, the second class carried out Project Based Learning learning, the third class carried out Discovery Learning, and the fourth class as control carried out learning with lectures and question and answer. Each group at the end of the learning

is given a post-test. The test questions used are multiple-choice forms with 20 questions that are adjusted to the problem-solving indicators. Data collection techniques in addition to using test questions and observation sheets to observe the implementation of learning. Giving a score on multiple choice test questions reasoned in a way: if the answer and reason is correct then get a score of 4, the wrong answer and the right reason got a score of 3, the correct answer and the wrong reason for score 2, the answer and the reason for wrong score 1, if not answer get a score of 0.

2.1. Research hypothesis

H0: There is no difference in problem-solving abilities in all experimental classes and control classes

Ha: There is at least one significant class in problem-solving abilities

2.2. Hypothesis testing

The score data obtained is then calculated on average for each class and then analyzed statistically using one-way variance analysis test (One Way ANOVA). If there is a significant difference in the One Way ANOVA test then it is tested further using the Post Hoc test.

To determine which is the most effective among the four learning models to improve students' ability in problem-solving with percentage descriptive analysis. The effectiveness of the learning model is determined based on the sequence of achievements from high to low.

Evaluation of each question:

$$N1 = \frac{\text{value obtained}}{128} \times 100\%$$

$$N2 = \frac{\text{the amount of value obtained}}{4}$$

Information:

N1 = Average value of each question.

128 = Maximum value of 1 question (4) x number of students (32)

N2 = Average value of one-dimensional problem solving

3. Results and Discussion

3.1. Student learning outcomes in problem solving

Data on learning outcomes of problem-solving abilities obtained from multiple choice reasoned tests with a total of 20 questions based on dimensions of problem-solving on ecosystem material are presented in Table 1.

TABLE 1: Student Learning Outcomes in Problem Solving.

No	Aspect	PBL	PjBL	DL	Control
1	Many students	32	32	32	32
2	Average value	58,63	54,94	51,31	50,44
3	Maximum value	75	68	66	74
4	Minimum value	49	43	38	35
5	Variance	34,37	46,19	54,54	75,74
6	Standard deviation	5,86	6,79	7,38	8,70

Based on Table 1, it appears that the PBL model has the highest order, the next order is the PjBL model, followed by the DL model, while the control class has learning achievement, in this case, the problem-solving ability, the lowest.

3.2. The dimension of problem solving ability in four learning models

Data of problem-solving abilities obtained from the results of students completing a multiple choice test reasoned with 20 questions in four classes with different learning treatments. The results of the analysis of problem-solving abilities in the learning model are presented in Table 2.

TABLE 2: Dimensions of Problem Solving Ability in Four Learning Models.

No	Dimensions		Learning (%)		
		PBL	PjBL	DL	Control
1	Solve meaning or identification	74	67	62	59
2	Use concrete steps to solve problems or design and	66	59	56	54
3	managing the project	46	44	42	40
4	Acquire, process, interpret, and	58	60	51	53
5	analyze information to make decisions	49	44	46	46
	Average	59	55	51	50
	Category	Enough	Enough	Enough	Enough

Based on Table 2, it appears that the PBL model has the highest achievement on the four dimensions of problem-solving ability. From this, it can be concluded that the

order of the effectiveness of the model to improve students' ability in problem-solving sequentially from high to low is the PBL, PjBL, DL and the last learning model with lectures and discussions (control class) although all of them are categorized as sufficient. This finding supports the results of Fitri's (2011) study which states that problem-based learning is designed to help students develop their thinking, problem-solving, and intellectual skills through various real situations or simulated situations, so that they become independent, autonomous learners.

In the dimension of solving meaning or identification, the PBL, PjBL, and DL models are in a good category, while the lecture and discussion models (control class) are in the poor category. The indicator used is finding, collecting, and describing various information then interpreting the problem including selecting, sorting, and focusing irrelevant information and relevant information. Activities like this have never been done in learning by lectures and discussions. Students just need to receive material from the teacher, things that are poorly understood are asked then answered by the teacher. In terms of mastering the concept students who are taught by lecture and discussion may not lose, but in high-level thinking, activities are less trained.

Dimensions use concrete steps to solve problems or design and manage projects, PBL is a good category, while PjBL, DL, and lecture with discussions are categorized as sufficient. The indicator used is designing or planning a strategy in solving a problem systematically, determining the objectives to be achieved, and outlining the problem in an orderly and logical relationship so as to form an integrated system. This includes the ability of students to make hypotheses, consider time in solving problems in order to produce an appropriate decision, and conclude the final decision appropriately. One alternative to improve students' ability to think critically by give questions that can spur the thinking process (Afcariono, 2008). Critical thinking can improve learning outcomes (Adnyana, 2012). Meanwhile, according to Wardhani (2008) Application of problem-based learning can improve students' problem-solving skills and learning outcomes.

In the third dimension, it is Acquiring, processing, interpreting and analyzing information to make decisions. There are no differences in achievements in the four learning models here, all of them are included in the sufficient category. This is because students are quite in the aspect of connecting including linking variables in completing in a multi-representation, integrating and structuring or solving problems in a planned manner. In addition, students are sufficient in applying, among others, applying the plan into a solution based on problem data, implementing or interpreting information into the interpretation of the problem in order to produce the right final decision, and operate or carry out strategies in solving problems. Slameto (2003) states that student learning

outcomes are influenced by internal factors and factors that come from outside the student or environmental factors.

In the fourth dimension, which is involved in the process of solving the highest achievement problems by the PjBL model. The PjBL Model is included in the good category while the other three models are in a sufficient category. The indicator used is organizing data in the form of diagrams (tables, graphs, and charts), and processing data to make it more perfect. In this case, students have been able to connect between variables, analyze or investigate problems, and draw conclusions. This is in line with research of Handayani & Sopandi (2017), the inquiry groups in PjBL has succeeded in motivating each member to contribute to the group seen in data collection, providing complete tools, understanding problem-solving tasks.

In the fifth dimension, all four models are sufficient, this is due to detecting, testing or checking the feasibility of the solution made and reading the question back and asking yourself about the feasibility of the solution made, the student is sufficient in criticizing aspects including assessing assumptions related to the solution made, looking at alternatives settlement others, and consider or check the logic of the solution made. Alternative knowledge in solving problems enrich students' knowledge. This finding is in accordance with Sanjaya's (2014) opinion that the problems raised in PBL are open problems. According to Satrianingsih et al. (2017), a problem-based learning model can improve attitudes towards science, namely social implications of science, attitudes toward scientific inquiry, and interest in science.

3.3. The effectiveness of four learning models on problem solving ability

Based on Figure 1. it is shown that the learning model according to the 2013 curriculum such as PBL, PjBL, and DL is superior in the problem-solving dimension of solving meaning or identifying. This can be caused by questions that are done in a type of routine with questions found in daily learning so that students can answer correctly. In the dimension of solving meaning or identification, students are good at identifying aspects, among others, students find, collect, and describe various information into the interpretation of the problem. While the less optimal learning model in the dimension of acquiring, processing, interpreting, and analyzing information to make decisions. There are two aspects to this dimension including connecting and applying. Connecting aspects, students are asked to link or connect variables in completing a multi-representation, integrating and structuring or solving problems in a planned manner.

Applying aspects include applying the results of the plan to the solution based on the problem data, implementing or interpreting the information into the interpretation of the problem in order to produce the right final decision, and operating or implementing a strategy to solve the problem. This is in line with the research of Ridlo & Irsadi (2012), that there is a development in the value of conservation-based character education that can start from simple things that occur in active and effective learning processes.
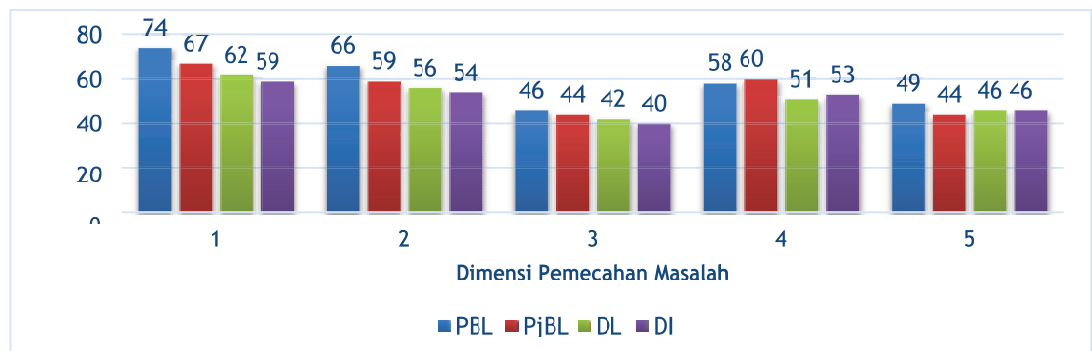

Figure 1: Graph of the Effectiveness of Four Learning Models on Problem Solving Ability.

Information:

1: Solve meaning or identification

2: Use concrete steps to solve problems or design and manage projects

3: Acquire, process, interpret, and analyze information to make decisions

4: Involved in the investigation process solve

5: Make connections and transfer learning from one situation to another Criteria (Widoyoko, 2013):

$\leq$ 20 %   : Very Less (VL)

20%-<40%   : Less (L)

40%-<60%   : Enough (E)

60% -<80%   : Good (G)

$\geq$80%   : Very Good (VG)

In this case, four models to find out students' problem-solving abilities are quite effective and the teacher should begin to reduce learning by lecturing and discussion. This is supported by Gagne in Wena's research (2009) that learning systematic problem-solving strategies can improve students' learning outcomes because in learning this systematic problem-solving strategy gives students the opportunity to systematically solve problems. the best way that can help students in problem-solving is to solve the

problem step by step by using certain rules. Ayuningrum & Susilowati Research (2015) states that discussion activities on the problems that are developing in the community can affect students' critical thinking skills to solve problems. According to Usman et al. (2017) besides that the group discussion model that teachers do can bring up different arguments from each student, so the learning atmosphere becomes more interesting and fun.

Susilowati & Anam (2017) asserted that learning biology at MA (Madrasah Aliyah) Khas Kempek is still dominated by teachers with low student involvement. Simple regression tests find a linear correlation between students' scientific reasoning and problem-solving abilities. This study confirms that reasoning ability is needed in problem-solving. In addition to competency in teaching, teachers must also have mastery of learning material well. Sukaesih et al. (2017) state that PCK (Pedagogical Content Knowledge) needs to be optimized in several aspects of content and pedagogic. It needs to be improved in terms of mastering the concept (content), the ability of teachers to manage effective classes, and the use of learning media that encourage students to actively learn.

4. Conclusion

Problem-solving abilities of the four learning models have different averages. There are similarities and differences in problem-solving abilities in the four learning models used. The results of the equation of problem-solving ability are only found in the DL model and lectures and discussions, while PBL, PjBL, and DL have significant differences with the results: 1) PBL models are better than PjBL, 2) the PjBL model is better than DL, and 3) PBL models are better than DL. It can be concluded that a good learning model in measuring problem-solving skills sequentially is PBL, PjBL, DL, and lectures and discussions.

The effectiveness of the four learning models is seen from the highest value in each dimension of problem-solving with the results: a) the PBL, PjBL, DL models are categorized as good and the lecture and discuss models are sufficient categories in the dimension of meaning solving or problem identification, b) PBL models are good, while the PjBL, DL, and lecture and discuss models are sufficient in terms of using concrete steps to solve problems or design and manage projects, c) PBL, PjBL, DL, and lecture models and enough discussion in the dimensions of obtaining, processing, interpreting and analyzing information for make a decision, d) the PBL, PjBL, DL, and lecture and

discussion models are included in the dimensions involved in the investigation process, and e) the PBL, PjBL, DL, DI models are sufficient in the dimensions of making connections and transferring learning from one situation to another

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