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Problem-Based Learning on Climate Change Theme:

Concept Mastery Profile and Problem Solving Skills of Secondary Students

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***Abstract*—Problem solving is one of 21st century skills should be pertained by young generation. The research aims to profile the problem based learning (PBL) implementation on climate change in one of secondary school at rural area in Indonesia. The increase of concept mastery and problem solving skills after the learning were also investigated. The research methods used was quasi-experimental with nonrandomized static group pretest posttest design. The experimental class consist of 40 students at 7th grade, learned science with problem based learning, meanwhile the control class with the same number of student used cooperative learning with team's game tournament (CL-TGT). The increase of concept mastery and problem solving skills were measured, using multiple choice with reason test. The research shows that PBL provide the better opportunity to enhance problem solving skills. The CL-TGT provides the largest portion for the preparation of mastery of concepts for the needs of playing games. Flipped learning (PBL and CL-TGT) is recommended to maximized problem solving skills as well as concept mastery.**

Keywords: problem solving skills, concept mastery, problem-based learning, cooperative learning

I. INTRODUCTION

The development of education at this time, enforce the implementation of natural science learning held interactively, fun, challenging and motivating students to participate actively, as well as providing sufficient space for creativity, and independence in accordance with the talents, interests, and physical and psychological development of students. Along the learning, students must actively construct knowledge, by processing material, digesting, thinking, analyzing, and finally the most important thing is to summarize knowledge as a whole understanding. Science concept mastery can be a provision for students to learn themselves and the natural environment, as well as a foundation in solving problems in daily life.

Concept mastery as well as problem solving skills are two main aspects in School Curriculum. Sumartini stated that the relevant learning method can enhance problem solving skills of student [1]. One of models can be use*d* to enhance problem solving skills is problem based learning (PBL). PBL is arranged to help student develop thinking skills, problem solving skills, and other intellectual skills. If students are trained to solve problems in learning, then students will be able to solve problems in a wider scope, in the real world.

In fact, the concept mastery and problem solving skills towards science of Indonesian student are need to be improved. Based on TIMMS reports (The Third International Mathematics and Science Study), Indonesian student position in science literacy is still low. PISA (Programs on International Student Achievement) report stated that the Indonesian student score in problem solving is still below the average [2]. Indonesian student also achieved low score in some indicators of scientific literacy, such as identify scientific problems, use scientific facts, understand life system, and use the apparatus in science laboratory. Rofi'udin [3] explained that today thinking skills has to be trains since elementary education. Suastra also stated that the low quality of science learning is caused by the benchmarks of educational success in schools are still focused on the concept [4]. Science learning so far has a tendency to only sharpen aspects of remembering and understanding, lack of training students in solving problems in the form of problem solving in which reasoning, argumentation and creativity are required.

Wells, Hestenes, and Swackhamer stated that student who attended the innovative learning got the higher achievement compare to the student who had the classical ones [5]. Based on Tan, when student learn something through the problems, this will lead to the deep thinking [6]. Barbara and Young also mentioned that problem based learning can facilitate student to be an active to solve the problem. Moreover, PBL can also develop student process skills.

Based on the description above, research on the implementation of PBL in science learning has been done on climate change theme in seven grade of secondary school. The learning implementation was then compared to the cooperative learning model with TGT in the same theme.

II. RESEARCH METHODS

The research method used was quasi experiment with nonrandomized static group pretest-posttest control group

design. The experimental and control groups consisted of 40 students of 7th grade. The research was done along the even semester of 2018/2019 periods, at one of secondary school in Bogor District, West Java-Indonesia. The experimental class was treated with PBL, meanwhile the cooperative learning with TGT was used for the control class (Table 1).

TABLE I. RESEARCH DESIGN

Group	Pretest	Treatment	Posttest
A	O_1	X_1	O_2
B	O_3	X_2	O_4

A : Experimental class; B: Control class;
O1 : Pretest in experimental class
O2 : Posttest in experimental class,
X1 : Problem Based Learning, PBL
X2 : Cooperative learning with TGT
O3 : Pretest in control class,
O4 : Posttest in control class

III. RESULTS AND DISCUSSION

The PBL class (experimental class) and the CL-TGT class (control class) were implemented for 4 meetings of which one meeting concists of 40 minutes. The pretest and posttest were conducted in both of class. In the first meeting, the topics learned were climate change and the factors affecting the climate change. The topics discussed in the second meeting were impact of climate change, adaptation, and climate change mitigation topics. One session before and after learning were used for the test. In the PBL class, the syntax used were (1) oriented student to the problems, (2) organized student to learn, (3) guided student to do the small group investigation, (4) developed and presented the product, and (5) analyzed and evaluated.

In the experimental class, teacher oriented student to the problem through the video and pictures to introduce student to the problems. Teacher stimulated student to ask what, why, and how about the video/figures content. Student showed very enthusiasm to ask. Every question was written on the board, so all of the student questions can be identified. Teacher gave the clues to answer the qualified questions. Teacher and then organized student into group of learning. Student discussed about the problem which should be solved. They tried to solve the problem through observation and literatures. They were asked to write all of they were discussed, observed, and learnt from some resources on using student worksheet. Along the observation, teacher did the guidance and gave feedback, for example through the question, ask for other alternative to solve the problem instead the irrelevant solution that proposed by student. At this stage, students generally face difficulties in finding ways to solve problems. This is because of the limit of resources of learning. Student could only access two or three books available in the library. Unfortunately, student didn't allow using gadget to find the information.

In the presentation stage, student in groups explain their solution with the argumentation. Teacher wrote all of the alternative solutions in the board. After that, teacher explain the subject climate changes and of climate change. Based on the teacher's explanation, students then discuss and compare with the solutions they proposed. Finally, students can find the most appropriate problem solving to use.

Teacher has an important role in problem based learning model. Teacher has to be a guide and a facilitator, and can be able to direct student gaining the knowledge and skills. Teacher must occasionally remind students to focus on an essential problem. Besides, teacher could help student to explore the qualified question. Arranging student in group shows the effective way to help student solving the problems. This is in line with previous research stated that a formation small group in PBL is needed to streamline student learning [7].

A. The Increasing Students' Concept Mastery

The well-organized teaching and learning will lead to the enhancing of concept mastery of student. This happens in problem-based learning that has been implemented. The enhancement of concept mastery is shown by data in table 2. Compared to the control class (which conducted learning with cooperative with TGT model), the experimental class shows better mastery of concepts. In average, the enhancement of experimental class is in fair category with the N-gain 56.21. Meanwhile, the enhancement of control class is in low category (N-gain = 24.83).

The result of data analysis on using SPSS 22.0 shows that concept mastery of student from the experimental class is higher than in control class (Table 3). The homogeneity test on using Levine test shows the significance r=0,086 or >0.05. Variants are homogeneous. The t test of the average score shows the sig value is (2-tailed) 0.00 or < 0.05. This is means that the concept mastery of both classes is significantly different.

TABLE II. DATA OF PRE-POSTTEST OF EXPERIMENTAL AND CONTROL CLASSES

Data	Experiment Class		Control Class	
	Pretest	***Posttest***	***Pretest***	***Posttest***
Lowest score (*min*)	40.00	63.33	30.00	43.33
Highest score (*max*)	73.33	93.33	73.33	90.00
Mean	55.00	80.08	54.75	65.92
Median	56.67	80.00	56.67	66.67
Modus	46.67	80.00	56.67	60.00
Standard of deviation	7.66	7.45	10.29	10.34
Number of Student	40	40	40	40
Average N-gain	56.21 (fair)		24.83 (low)	

TABLE III. NORMALIZATION TEST OF THE PRE-POSTTEST DATA OF CONCEPT MASTERY FOR BOTH CLASSES

Data	Class	Sig.	Result
Pretest	Experimental	0.170	Normal
	Control	0.274	Normal
Posttest	Experimental	0.146	Normal
	Control	0.478	Normal

Tan states that PBL has an advantage in strengthening concepts because of the more meaningful nature of learning compared to the usual group discussion methods, due to the teacher's more optimal effort to learn students [6]. The results

shows that PBL can enhance the concept mastery of student. This is in line with Akinoglu and Tandoganand Rusnayati [8,9]. Compared to PBL, learning with cooperative learning lacks intensive guidance on how concepts are discovered by students. TGT strategy is considered to be less challenging for students to think (emphasizing memorization in order to win the contest) so that meaningful learning is not well observed.

B. The Increase of Problem Solving Skills

The better arrangement in problem based learning will lead to the problem solving skill student. The stages of PBL implemented were (1) problem identification, (2) problem diagnosis. (3) Strategy planning. (4) Strategy implementation and (5) Learning evaluation [10]. The test was done by both of class, before and after learning. The result statistically shows in table 4.

In the PBL class, students were trained to seek for the solution of the problem posed by their selves. The problem was initiated by teacher through exposed a phenomenon from their daily life. Student used their higher order thinking skills to solve the problem. Higher order thinking will arise when student face on the problem close to their daily life. Students were very enthusiasm and challenged to understand the problem (in the picture showed by teacher). They tried to use their meaningful learning come from the challenging learning. By this learning, students in the experimental class eager to present the product they produce confidently [11]. Moreover, Nendaz and Tekiaz [12] and Bransford and Stein [13] elaborated that PBL is not only increasing concept mastery, but also shows the potential to enhance thinking skill in order to solve the problem. The cooperative learning with TGT gives less facilitation to enhance problem solving skill. The point view of this model more gives a chance to facilitate rote learning, because of the needs to win the game.

TABLE IV. STATISTIC DESCRIPTIVE OF EXPERIMENTAL AND CONTROL CLASSES

Data	**Experimental Class**		**N-gain**	**Control Class**		**N-gain**
	Pre	***Post***		***pre***	***post***	
Lowest Score	43	53	48.4 fair	43	53	29.9 Low
Highest Score	73	93		73	87	
Mean	57	77		56	69	
Median	57	77		57	70	
Modus		77		60	63	
SD	7.5	11.1		8.0	6.8	
N	40	40		40	40	

IV. CONCLUSION

Based on the research, the problem based learning gave some opportunities to student to enhance both of concept mastery and problem solving skills. The PBL learning led the concept mastery as well as problem solving student with the fair category, significantly better than Cooperative-TGT learning with low category for both. The positive correlation is shown between concept mastery and problem solving skills as well.

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