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# Improving the Students' Creative Thinking using Problem Based Worksheet on the Topic of Environmetal Pollution

**Ni Wayan Nila Sri Lestari, Noor Fadiawati*, Tri Jalmo**

Graduate School of Science Education, Faculty of Teacher Training and Education, Universitas Lampung, Indonesia.

*Corresponding e-mail: noor.fadiawati@fkip.unila.ac.id

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**Abstract: Improving the students' creative thinking skills using problem based worksheet on the topic of environmental pollution. Objectives:** This research aims to investigate the effectiveness of problem based worksheet to improve students' creative thinking skills on the topic of environmental pollution. **Methods:** Creative thinking skills were measured using four indicators: fluency, flexibility, originality, and elaboration. The research was designed using the matching only pretest-postest control group design. The data of creative thinking skills were collected from pretest and posttest and analyzed using statistical analysis such as normality, homogeneity, t-test, and Mann-Whitney test. **Findings:** Students' elaboration skill showed the highest improvement related to the effect size (0.92) and n-gain value (0.73). **Conclusion:** The problem based worksheet is effective to improve students' creative thinking skill.

**Keywords:** Worksheet, problem based learning, creative thinking skill.

***Abstrak: Meningkatkan keterampilan berpikir kreatif siswa menggunakan lembar kerja berbasis masalah pada topik polusi lingkungan. Tujuan:*** *Penelitian ini bertujuan untuk menyelidiki efektivitas lembar kerja berbasis masalah untuk meningkatkan keterampilan berpikir kreatif siswa pada topik pencemaran lingkungan.* ***Metode:*** *Keterampilan berpikir kreatif diukur menggunakan empat indikator: kelancaran, fleksibilitas, orisinalitas dan elaborasi. Penelitian ini didesain menggunakan the matching only pretest-postest control group design. Data keterampilan berpikir kreatif dikumpulkan dari pretest dan posttest setelah menerapkan analisis statistik menggunakan uji normalitas, homogenitas, t-test, dan Mann-Whitney.* ***Temuan:*** *Nilai effect size dan n-gain adalah 0,92 dan 0,73 yang bermakna terjadi peningkatan yang signifikan pada keterampilan elaborasi siswa.* ***Kesimpulan:*** *Lembar kerja berbasis masalah cukup efektif untuk meningkatkan keterampilan berpikir kreatif siswa.*

***Kata kunci:*** *Lembar kerja siswa, pembelajaran berbasis masalah, keterampilan berpikir kreatif.*

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## INTRODUCTION

Science aims to develop the experience and competence of students to use, propose and test hypotheses through experimenting, designing and assembling experimental instruments, collecting, processing and interpreting data, and communicating experimental results both verbally and in writing (Simsek & Kabapinar, 2010). In addition, Science aims to develop thinking skills and mastery of student concepts. Science learning is expected to contribute in preparing the availability of human resources as a creative generation that has creativity and is able to compete in the era of globalization (Zhao, 2010). Therefore, the process of science learning must prepare the science-conscious students (scientific literacy), value, attitude and higher order thinking skills (Gunn, Grigg & Pomahac. 2008).

Creative thinking is a part of higher order thinking skills and a cognitive aspects to be considered in the science learning process in the classroom (Awang & Ramly, 2008; DeHaan, 2009). By thinking creatively, students will try different perceptions, concepts, and perspectives, so that they can use different ways to solve problems, generate ideas or ideas which is better, more satisfying and more creative (Awang & Ramly, 2008). But the facts on the ground, students' creative thinking skill is still low. This matter is seen in the results of the Program for International Study Assessment (PISA) test in which Indonesia in 2012 was ranked 64th out of 65 countries and 69th out of the 76 countries participating in 2015. Indonesian students aged 15 years have not been able to answer test questions at levels 5 and 6 which were complex questions requiring high-level thinking skills involving cognitive activity (OECD, 2013).

Learning activities are still lacking in facilitating students to develop their thinking skills. Teachers did not facilitate students to think creatively. Teachers had not designed a learning process that stimulates the ability to think creatively. Many teachers were unaware of the various forms and manifestations of creative thinking and how creativity can be integrated in learning so as to build both creative thinking skill and academic (Tan & Grigorenko, 2010). Science learning has been focused only on how to improve students' cognitive knowledge. Implementation of thinking processes still rare so that students were less able to learn how to apply scientific concepts in real life outside school.

One way is to involve students to be more active in learning. In order for students to be active in learning, teachers must apply and develop science learning creatively and innovatively. To develop science lessons, teachers are required to design and implement science experiments that support learning. In this case, teachers need to use instructional media and relevant learning resources to achieve the learning objectives in their entirety. One of the learning media that can be used to support the learning process is worksheet (Yildirim, Kurt, & Ayas. 2011). The worksheet is a guide for student that can be used in observation, experimentation, and demonstration activities to facilitate the process of investigating or solving a problem. Therefore, teachers need to use worksheet to foster student creativity by asserting more student-centered activities, connecting with real life, containing open-ended questions, and creative thinking impulses (Trnova, 2014) so as to tap into students' creative thinking skills.

One of the materials that can be taught by using worksheet is environment pollution for students grade VII that are contextual and related to real life problems. This material deals with basic competencies that require students' thinking skills to solve problems. To achieve the basic competencies, then the learning steps in the worksheet should be able to guide students to formulate and analyze the problem, and solve the problem by proposing ideas. Therefore, it takes a learning model that can train problem-solving ability such as Problem Based Learning (PBL)

model. This learning model is based on real-life problems as a context for students to learn about problem-solving skills while challenging students to learn and work in groups to find solutions to real-life problems (Sul Hou, 2014) requiring creative thinking (Bilgin, Senocak & Sozbilir, 2009).

In PBL, the focus of learning lies on the chosen problem so that students not only learn the concepts related to the problem, but also the scientific method to solve the problem. Students not only understand concepts that are relevant to the issues of interest but also acquire learning experiences related to the skills of applying scientific methods in problem solving and fostering creative thinking patterns (Karimi, 2011). Application of PBL model can make it easier for students to solve problems with various alternative solutions, and can identify the cause of existing problems. Therefore, it is important to apply worksheet based on PBL to increase student's creative thinking skill. Many studies related to the implementation of worksheet based on PBL in science learning had been conducted, among them were research result (Koh et al., 2008; Schmidt, Rotgans, & Yew, 2011; Tseng et al., 2011; Padmavathy & Mareesh, 2013) stated that worksheet with PBL model was effective to improve students' creative thinking skill. The results also suggest that worksheet based on PBL could improve the creative thinking skill with mean of n-Gain of 0.73 with high criterion. Based on this, the researcher was interested to conduct this research which aims to find out the effectiveness of worksheet based on PBL to improve student's creative thinking skill.

## ■ METHOD

This research used quasi experimental design that was the matching only pretest-posttest control group design. The effectiveness of worksheet based on PBL was seen from the data of student's creative thinking skill obtained from pretest and posttest scores which analyzed using tests of normality, homogeneity, t1, t2, and Mann-Whitney U. This research was conducted in Public Junior High School 20 Bandar Lampung. The determination of experiment and control class was did through matching class by giving pretest for four classes, that were class $VII_K$, $VII_L$, $VII_M$, and $VII_N$. Furthermore, the pretest scores was tested by the two-average-equations test. Based on the result of the test, the samples had chosen were the students of class VIIM as experimental class and VIIN as control class. The experimental class was taught using worksheet based on PBL, while the control class was taught using conventional worksheet. In the meantime, the posttest scores of experimental and control class was tested by a two-average-difference test.

The improvement of students' creative thinking skill was described by n-Gain value. Furthermore, the n-Gain values were interpreted by using the criteria: g > 0,7 (high), 0,3 < g d" 0,7 (medium), and g < 0,3 (low). Besides using n-Gain, to find out the impact of worksheet based on PBL could be seen from effect size. The effect size value then was categorized based on the Cohen Standard criteria: d < 0.2 (no contribution), 0.2 < d < 0.5 (small), 0.5 < d < 0.7 (medium) and d > 0.7 (large).

## ■ RESULT AND DISCUSSION

Prior to the effectivity test of problem based worksheet, the sample normality test is first carried out to the experimental and control classes. Based on result of normality test of posttest scores in Table 3, it was obtained the Significance value on experimental class was 0.002 ($p < 0.05$), then the sample was not normally distributed. Moreover, the significance value for control class was 0,030 which also indicated the unnormally distributed.

**Table 3.** The result of normality tests for posttest by experimental and control classes

| Tests of Normality | | | | | | |
|---|---|---|---|---|---|---|
| Class | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Exp. | .214 | 29 | .002 | .890 | 29 | .006 |
| Control | .171 | 29 | .030 | .907 | 29 | .015 |

*a. Lilliefors Significance Correction*

Since the two classes were not normally distributed, a two-average difference test was did by Mann-Whitney U test. The results of Mann-Whitney U test on the experimental and control classes are presented in Table 4. Based on the result of Mann-Whitney U test in Table 4 obtained value of Sig. (2-tailed) both was 0.000 < 0.05, so $H_0$ was rejected, meaning that the mean posttest scores of the two classes was significantly different. This suggests that the implementation of worksheet based on PBL in the experimental class was more effective to improve students' creative thinking skill compared to conventional worksheet in the control class. Then, the testing results of n-Gain values in the experimental and control classes are 0.73 (high) and 0.27 (low), respectively.

**Table 4.** Result of Mann-Whitney U tests for posttest by experiment and control class

| Class | Ranks | | | Test Statistics[a] | |
|---|---|---|---|---|---|
| | N | Mean Rank | Sum of Ranks | Test | Posttest |
| Exp. | 29 | 43.00 | 1247.00 | Mann-Whitney U | 29.000 |
| Control | 29 | 16.00 | 464.00 | Wilcoxon W | 464.000 |
| Total | 58 | | | Z | -6.090 |
| | | | | Asymp. Sig. (2-tailed) | .000 |

Based on the Table 5, it is known that the mean posttest and n-Gain in the experimental class is higher than the control class. This was cause of the different treatment of both classes. This fact indicates that students' creative thinking skill in experimental class using worksheet based on PBL was higher than control class using conventional worksheet. This means that the use of worksheet based on PBL was effective to improve student's creative thinking skill. This is supported by the results of research which states that the implementation of worksheet based on PBL could improve the creative thinking skill with mean of n-Gain was 0.73 with high criteria. The use of worksheet based on PBL was effective to improve students' creative thinking skill.

The students' creative thinking skill was judged by the answers to the pretest and posttest questions. The testing questions have been compiled based on the indicators of creative thinking skill. Creative thinking skills includes to four indicators were fluency (producing or giving many ideas or questions related to the problem), flexibility (providing various interpretations of a problem and can take alternative solutions to problems), originality (producing or giving new ideas), and elaboration (developing or perfecting ideas). The results of students' creative thinking skill testing can be seen in Table 6.

**Table 6.** Value of students' creative thinking skills

| Indicators | Experimental Class | | | Control Class | | |
|---|---|---|---|---|---|---|
| | Score | | *n-Gain* | Score | | *n-Gain* |
| | Pretest | Posttest | | Pretest | Posttest | |
| A | 29,89 | 81,32 | 0,73 | 24,43 | 47,7 | 0,30 |
| B | 17,3 | 73,1 | 0,67 | 16,84 | 39,83 | 0,27 |
| C | 10,34 | 72,41 | 0,69 | 8,05 | 30,75 | 0,25 |
| D | 18,97 | 86,21 | 0,83 | 29,02 | 44,83 | 0,14 |
| $\bar{X} \pm$ Sd | 19,13±8,09 | 78,26±6,67 | 0,73±0,07 | 19,59±9,18 | 40,78±7,43 | 0,24±0,0 |

Explanation: A: *fluency*; B: *flexibility*; C: *originality*; D: *elaboration*; K = Criterion; $\bar{X}$ = Mean; Sd = Standard deviation; S= Very high; T = High; S = Medium; R = Low; SR = Very low

Based on the Table 6, it is known that there are the improvement mean of students' creative thinking skill with high criteria in the experimental class and low criteria in the control class. Mean of creative thinking skill indicators in the experimental class was 67% higher than the control class. The improvement occurs due to the influence of PBL process which takes place every stage in problem orientation stage, student task organization, conducting individual and group investigation, present and develop the work and analyze and evaluate problem solving process. This was supported by the results of the study which states that PBL activities trained students to develop knowledge and express ideas that were more creative so that PBL had given positive impact in improvement of students' creative thinking skill.

Learning activities of the PBL model made students in the experimental class able to express and develop ideas maximally to discover and formulate problems that then decide their own hypothesis based on the information they collect. After that they tested their own answers by designing and experimenting independently and in groups to get the data. This stimulates them to think flexibly and can provide new ideas with variations. Based on the results of the experiments they obtained, they then analyzed the existing data and examined the correctness of the hypothesis, so that the thinking process developed and they were trained to detail the data it encountered. They then evaluated their work by providing an assessment or response to their work and the work of their friends. That way they could explore existing ideas and ideas so that their creative thinking skills increase. This was also supported by the results of the study which revealed that the implementation of PBL made it easier for students to solve problems with a variety of alternative solutions, as well as to identify the causes of existing problems. This could improve student's creative thinking skill.

The improvement of student's creative thinking skill occured cause the contribution of each indicator of creative thinking skill trained within the worksheet. Based on the results of data analysis, the indicator of creative thinking skill had improved every learning stage. The improvement each indicator of creative thinking skill in both classes can be observed from the value of n-Gain are shown in Figure 1.

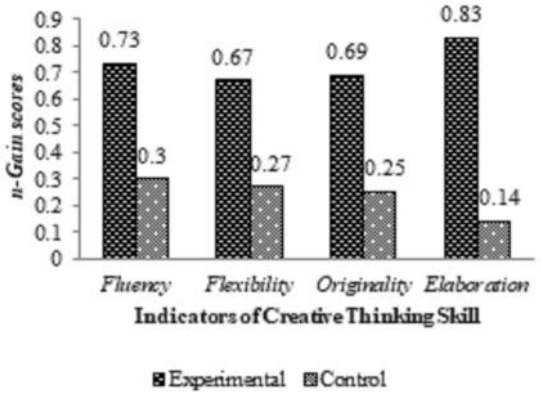


**Figure 1.** *n-Gain* of experimental and control classes based on indicators of creative thinking skill

Based on the Figure 1, n-Gain scores of each indicator of creative thinking skills in the experimental class were higher than the control class. There was a difference of n-Gain scores on the four creative thinking skill indicators in the experimental class, namely high criterion on fluency and elaboration indicators, while the indicator of flexibility and originality was moderate. The result of the Mann Whitney U test was known that there was a difference between both classes. The magnitude of the impact of using worksheet based on PBL on student creative thinking skill can be seen through the calculation of effect size. The result of effect size calculation for posttest scores is 0.92. Then, this value was interpreted using the Cohen Standard criteria. The result of interpretation showed the effect size was 0.92 > 0.7 with large category. This showed that there was large impact from the use of worksheet based on PBL to improve student's creative thinking skill. The magnitude of this effect size can be proven from the distribution of posttest scores of the students in both classes are shown in Figure 2.

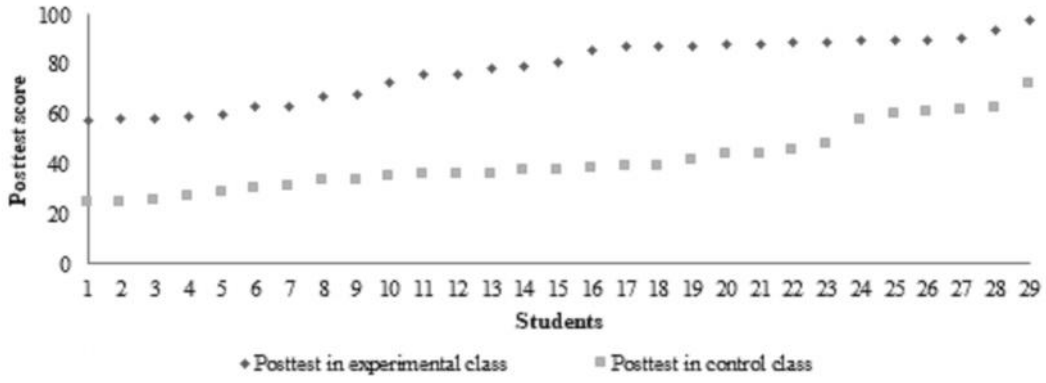


**Figure 2.** Distribution of students' posttest scores in the experimental and control classes

Based on the graph above (Figure 2) it is known that there is no overlaping point, so the value of the effect size is large, it's meaning that the posttest and n-Gain values are really influenced by the use of the worksheet based on PBL. Although the value of n-Gain on flexibility and originality were medium criterion, but with effect size value of 0.92 with large category was enough to describe difference of improvement students' creative thinking skill in both classes that was experimental class was higher than control class.

The result of the improvement of each indicators of creative thinking skill which was trained through worksheet based on PBL is described as follows.

### 3.1 Fluency

Indicator of fluency in the experimental class had the high improvement, it seen from the n-Gain value of 0.73 (high criterion), while n-Gain students in the control class was only 0.3 (low criterion). The high n-Gain of experimental class students occured cause in the problem orientation stage, students were faced with real phenomena related to environment pollution. In this stage, students were guided to observe the phenomenon and identify problems that occur so that they could reveal a number of ideas or answered to write the problem formulas. This was consistent with the assertion that PBL learning begun with a problem related to the student's real environment. This situation or problem that encouraged them to find the problem and solve it. For example in worksheet 1, the teacher provided a phenomenon related to air pollution caused by motor vehicle

fumes. This problem was an unstructured problem and close to the students' life. This was the characteristics of PBL learning that the firstly students was confronted with a less structured or less defined, open ended and contextual problem which was further solved through work in group. Through the phenomenon was giving, students could define the problem that was about one cause of air pollution and its impact to health.

After students observed the phenomenon was provide, the teacher then guided the students to write the problem formulation in accordance with the air pollution problem related to how to cope with the pollution. For example in group 2, at first in worksheet 1 students had not been able to write the problem formulation correctly, then there was improvement of writing problem formulation on worksheet 2, worksheet 3, until worksheet 4. The example of formulation of problems which created by students in the worksheet about fluency as shown in Figure 3.

trained was the ability to make the question shown by the students write the problem formulation in the form of question. This was in accordance with the opinion that provided questions about the available phenomenon was a preliminary activity of the implementation of creative thinking. Activity raising questions was vital for improving curiosity in students and focusing on the subject. In addition, students could also be train to analyze opinions by examining the inaccuracy of information contained in the phenomenon was provided.

### 3.2 Flexibility

Indicator of flexibility in the experimental class had a medium improvement, seen from the n-Gain value of 0.67 (medium criterion), while the n-Gain of the students in the control class was only 0.27 (low criterion). This matter cause at the organizational stages of learning tasks, students

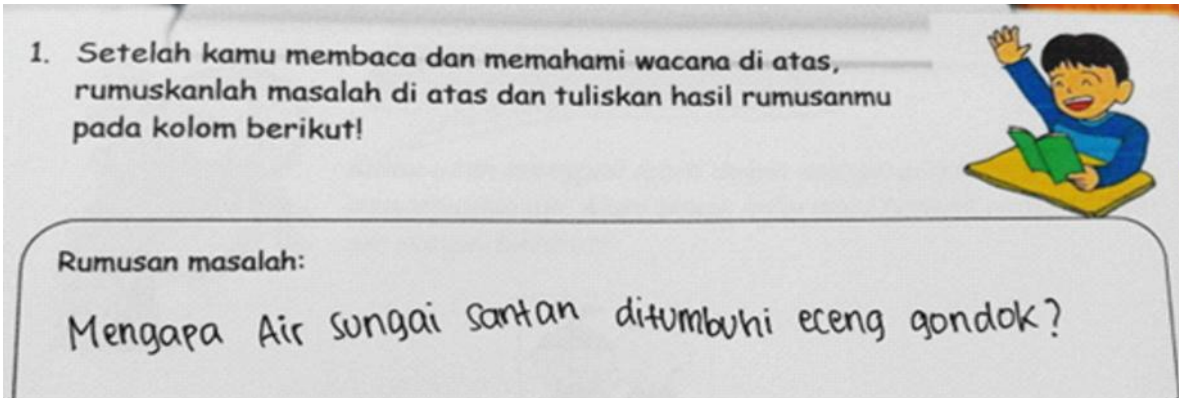


**Figure 3.** An example of formulation of problems created by students on worksheet 2

Based on the Figure 3, it appears that students had been able to write the problem formulation in the form of questions. This indicates that problem orientation activities can train students' fluency thinking skill through the process of observing and identifying problems based on phenomena related to air, water, soil, and sound pollution. Sub-indicator of fluency that was

sought the information from various sources (books or internet) related to sub-material of environment pollution on work done worksheet. Information search was guided through the assignment sheet. The information to be sought by the students had been determined to fit the knowledge indicator that the student must

achieved. This activity trained students to work together and share tasks in solving problems.

In addition to seek information at the organizational stage of the learning task, at the inquiry stage, students were also trained to design simple experiments related to water and soil pollution. In this activity, students were trained to make problem formulations and hypotheses (temporary answers) based on brief phenomenon provided and determine experiment variables. The ability to construct of hypotheses and plan experiments was a cognitive activity in higher-order-thinking. Before determine the variables, students learned the concept of the variables provided in the worksheet, then they defined their own variables according to their experiment design. Sub-indicator of flexibility that trained was determine the idea or answer to question was given in different condition or problem. The sample answers to the worksheet question about the determination of experiment variables can be seen in Figure 5.

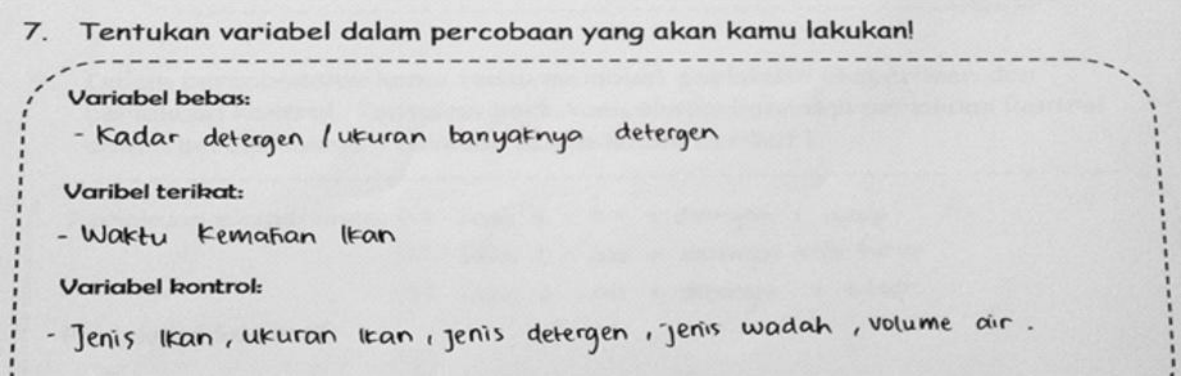


**Figure 5.** An example of experiment variables created by students on worksheet 2

Based on the Figure 5, it appears that students were able to determine experiment variables. This indicates that the process of designing experiment in investigative activities could train flexibility thinking skill that was students had been able to determine the independent, bound and control variables that would be use as the focus point of the experiment. This was consistent with the assertion that predicting variables was the main exercise of creative thinking, one of which was thinking flexibility.

### 3.3 Originality

Indicator of originality in the experimental class also had a medium improvement, judging by the n-Gain value of 0.69 (medium criterion), while the n-Gain students in the control class was only 0.25 (low criterion). This matter cause in the inquiry stage, students in the experimental class were trained to design and conduct simple experiment related to water and soil pollution using the tools and materials that had been provided. Trial activity was an important activity in an investigation that used a scientific approach to answer a problem. This activity aims to tested the hypothesis that had been made by students at the beginning of the investigation. Previously, at the organizational stage of the students' learning tasks, they were trained to develop experiments that others had conducted in relation to water and soil pollution through information seeking activities with guidance sheets, so that they had gained knowledge of experiment action steps. With the tools and materials provided, the students were then guided to determine the title, objectives, benefits, and experiment steps, and determined between the experiments an contol treatment on their designing result. After that, students

conducted an experiment based on the designing results. After they did the experiment and obtained data, students then trained to compile the experimental data in the form of tables or graphs in their own way.

This means that the experimental students were trained to give different answers when they was given a problem and they gave their own ideas by improving the ideas of other people. The experiment activity was carried out on worksheet 2 (water pollution) and worksheet 3 (soil pollution). Sub-indicator og originality was the ability to give new ideas to solve the problem.

### 3.4 Elaboration

Indicator of elaboration in the experimental class had a high improvement, judging by the n-Gain value of 0.83 (high criterion), while the n-Gain students in the control class was only 0.14 (low criterion). This matter cause in the stage of developing and presenting the results of students' inquiry on the experimental class had given some discussion of questions related to the investigation or experiment which had done by them. Through these questions, students could train their ability to develop their ideas.

Students' elaboration abilities were also trained at the stage of analyzing and evaluating the results of problem solving. At this stage students were guided to reveal the constraints faced when conducting an investigation or experiment, checking the hypothesis, making conclusions, and providing an assessment (feedback or question). This means that the experimental students were trained to describe their idea in detail. While in the control class, learning by lecture method and regular discussion had not made the students able to develop ideas and describe their idea in detail. Therefore, the students' elaboration ability in the control class was lower than the students in the experimental class.

Based on the n-Gain value of each indicator of creative thinking skills in the experimental class, the highest improvement of students' creative thinking skill was elaboration indicator (detailing and developing ideas), then the second indicator was fluency, the third was originality, and the fourth or lowest was flexibility. The fluency was in second place with a high improvement cause in the beginning of the PBL activities, students were always trained to identify and define the problem, so that they were able to express a number of answers fairly well or correctly. They could give an idea or reason to solve the problem was giving. This was in line with the results of the study which states that there was a high improvement of fluency cause the students had been fluent in suggesting ideas or answers in discussion and presentation activities with worksheet based on PBL. The questions of creative thinking ability in worksheet could stimulate students to generate many ideas. The results of the study also showed that there was a significant difference in the fluency between the experimental and control class.

The flexibility was the lowest indicator because the students were not yet accustomed to provide the interpretation or analysis of different conditions in different ways. Students need to be trained continuously by providing a great concept. The originality was the thirth because students were not used to expressing and pouring ideas. This matter cause students had became accustomed to learning copying answers from books, so their ideas can not develop. Thus, students need to find other literature to develop their ideas.

The elaboration was the highest indicator cause when learning process in the class, students were invited to describe their idea or concept in detail, as well as in the experimental class students were trained to develop ideas related to experiment results or research data of others through a series of discussion questions the results

of the investigation, reveal the obstacles faced in the investigation, as well as draw conclusions on the results of his investigation. This matter was accordance with the opinion that the high improvement of elaboration was the result of practicum activity with worksheet based on PBL. Students seek to expand their ideas and seek alternative answers from various sources independently, creatively and curiosity. In addition, the results of the study also supported that through PBL, students became aware of how to analyze problems was provided through theory and practice and had professional skills to address real-life problems.

Based on the results of research that had been described proved that the implementation of worksheet based on PBL could to improve students' creative thinking skills significantly which integrated with the achievement of basic competence for the environment pollution subject in grade VII of Public Junior High School 20 Bandar Lampung. This matter cause the investigations using worksheet based on PBL encouraged curiosity, motivate, and enhance cooperation among in group members. The results study also supported that worksheet was more activated of students and improved the learning success. In addition, learning with the PBL model could improve the ability of communicating both writting and oral. When the student was able to communicate in writing and orally, then they will be trained to express and develop their creative ideas so as to enhance their creative thinking skills. Therefore, the implementation of worksheet based on PBL was effective to improve students' creative thinking skills.

## ■ CONCLUSION

Based on the results and discussion, so can be concluded that worksheet of environment pollution based on PBL was effective to improve students' creative thinking skills. The average of improving of students' creative thinking skill was high criterion. The effect size value of the use of worksheet based on PBL to improve students' creative thinking skills also had large criterion. Suggestion that can be given are teachers need to use worksheet of environment pollution based on PBL to improve students' creative thinking skill. In addition, further researchers need to use worksheet with the similar characteristics on other science materials.

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