Enhancement of students' creative thinking skills on mixture separation topic using project based student worksheet

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Enhancement of students' creative thinking skills on mixture separation topic using project based student worksheet

R Nurisalfah*, N Fadiawati and T Jalmo

Teacher and Education Faculty of Lampung University, Indonesia

*Corresponding author's e-mail : resti.nurisalfah@gmail.com

Abstract. The aim of this study is to describe the effectiveness of project based student worksheet in improving students' creative thinking skills. The research method is using quasi experiment with the matching only pre-test post-test control group design. The population in this research is all students of class VII SMP N 2 Belitang Madang Raya with class VII1 as control class and class VII4 as experiment class. The sample of this research is obtaining by purposive sampling technique. The effectiveness of project based student worksheet is based on significant post-test differences between the control class and the experiment class as well as the effect size. The results show that the using of project based student worksheet is effective in improving students' creative thinking skills on mixture separation topic.

1. Introduction

Science education has an important role in producing quality human resources. However, it seems that science learning is still reaping many problems and not in accordance with the expected. Based on the results of Trends in International Mathematics and Science Study (TIMSS) report in 2011, Indonesia was ranked 36 out of 49 countries [1]. Then, the 2015 Program for International Student Assessment (PISA) report shows that the new Indonesia had just ranked 69 out of 76 countries. The low achievement of Indonesian students in the TIMSS and PISA studies was a portrait of the unsuccessful learning of science and the low level of students' thinking skills.

The thinking skills are mainly creative thinking is still very low, both thinking skills possessed by basic education graduates and college graduates [2]. The low level of creative thinking skills of students is due to the dominant schooling that is still dominating in memory and convergent thinking ability, the ability to find the most appropriate answer to the problems given based on available information [3]. So if students are faced with other problems that are more complex and with different conditions, students will find it difficult because students are accustomed to convergent thinking and not used to thinking about many other alternatives in problem solving (creative thinking).

One of the causes of low creativity of students is also sourced from the implementation of learning that still apply conventional methods, where learning activities are still centered on teachers and students tend to be passive [3]. The result of structured interview towards six science teachers in east OKU indicates that 100% of teachers still used lecture method (conventional method) while teaching science especially mixed separation topic and not yet trained creative thinking skill. So required a means of learning that can make students active and trained in their thinking skills. In order to manifest the learning that can train the skills of thinking, teachers should be able to facilitate students and must keep the learning steps can run systematically. One of the means of learning that teachers

can use to train students to think in the learning process is the Student Worksheet [4]. The student worksheet can be designed and developed according to the conditions and situations of the learning activities encountered [5], so the steps in the student worksheet should be designed in such way that the basic competence of the students can be achieved well.

One of the basic competencies of knowledge in science in the seventh grade at junior high school is "understanding the concepts of mixed and single substances (elements and compounds), physical and chemical properties, physical and chemical changes in daily life" with basic competence of skills is "presenting the results of the Investigation or work about properties of the solution, physical change and chemical change or mixed separation" [6]. When viewed from that basic competence, students are faced with real problems until finally can produce a work based on the results of the investigation, which of course requires thinking skills, especially creative thinking skills. If the basic competence is stated in the student worksheet, then the steps in the student worksheet should be oriented to a work based on the results of the investigation, so that the student worksheet that matching with the basic competence is student worksheet based on project based learning.

The project based learning model is chosen because it involves students in complex issues, real world issues, requires students to investigate, and requires students to find solutions to the problems with project [7]. Project based learning is an innovative learning approach that implements strategies that lead to the improvement of thinking skills, where the learning is controlled by students and teachers only as facilitators [8]. Through project based learning students become more actively encouraged in learning and the creativity of students grow [9].

Some research results show that project based learning can improve students' creative thinking skills [3,10,11] and improve student's learning outcomes [12,13,14,15,16]. Based on the description, the author aimed to describe the enhancement of student's creative thinking skills on mixtures separation topic using project based student worksheet.

2. Methods

The method used was quasi experiment by using the matching only pre-test post-test control group design that presented in Table 1 [17]. The research conducted in SMP N 2 Belitang Madang Raya. The samples were obtained by purposive sampling technique. All of the seventh grade students in 2016/2017 that spread at four classes, were given a pretest to know which classes were matching and had the criteria to be sample. The pretest score were tested using the t- test and found that there were four pairs of classes that had criteria to be sample. Those were class VII.1 and VII.3; Class VII.1 and VII.4; VII.2 and VII.3; VII.3 and VII.4. In this study, author chosen class VII1 as control class and class VII4 as experiment class.

Table 1. Research design.

Class		Treatment		
Experiment	M	O_1	X	O_2
Control	M	O_1	C	O_2

Description: M is matching, O1 is pretest, X is learning using project based student worksheet, C is learning using conventional student worksheet and O2 is posttest.

3. Results and Discussion

3.1. T-test, n-Gain and Effect Size

The average of pretest and post-test of creative thinking skills in control and experiment classes are presented in Figure 1.

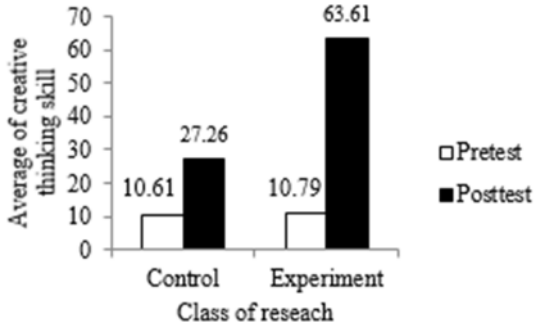

Figure 1. The average of pretest and posttest of creative thinking skills in control and experiment class

Next, the result of normality test of posttest in control and experiment class can be seen in Table 2. The results of homogeneity test and t test are presented in Table 3.

Table 2. $D_{calculation\ result}$, D_{table} for control and experiment class.

Class	$D_{calculation\ result}$	D_{table}	Description
Control	0,189	0,281	Normal
Experiment	0,144	0,281	Normal

Table 3. Score of variance, $F_{calculation\ result}$, F_{table}, $t_{calculation\ result}$ and t_{table} for control and experiment class.

Class	Variance	$F_{calculation\ result}$	F_{table}	Description	$t_{calculation\ result}$	t_{table}	Description
Control	232,33	1,01	2,09	Homogen	17,982	2,021	Significantly different

Table 3 shows that calculation result = 17,982 was bigger than table then reject H0, it meant there is a significant difference between mean posttest of creative thinking skill in experiment class and control class. Based on the calculation of n-Gain of creative thinking skill in the experiment class, we got the average of n-Gain was 0,56 (moderate category). Then the average of n-Gain for each aspect of creative thinking skills in the experiment class was shown in Figure 2.

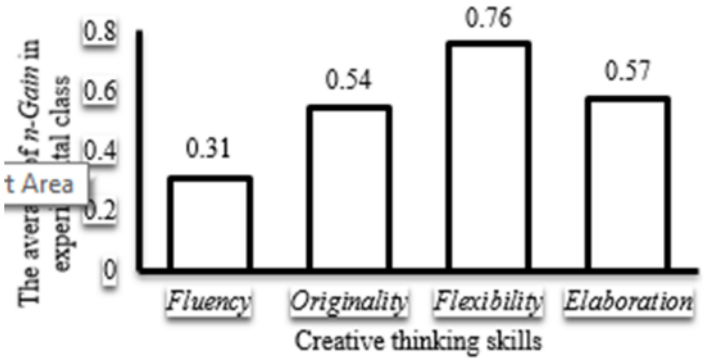

Figure 2. The average of n-Gain for each aspect of creative thinking skills in the experiment class.

T test provides us with information about whether there is a significant difference between the control class and the experiment class. However, it does not provide information how big the difference is. To know the difference between the control class and the experiment is calculated the effect size. Effect size is important to find because it can inform the size of the impact [18]. Based on the result of calculation, there is an effect size of 0.93 (large category). The magnitude of differences between control and experiment class can be seen from Overlapping posttest in the control class and experiment class. The fewer posttest that overlap each other, the effect size was greater, so was the other way. Figure 3 shows the spread of the posttest in control class and the experiment class.

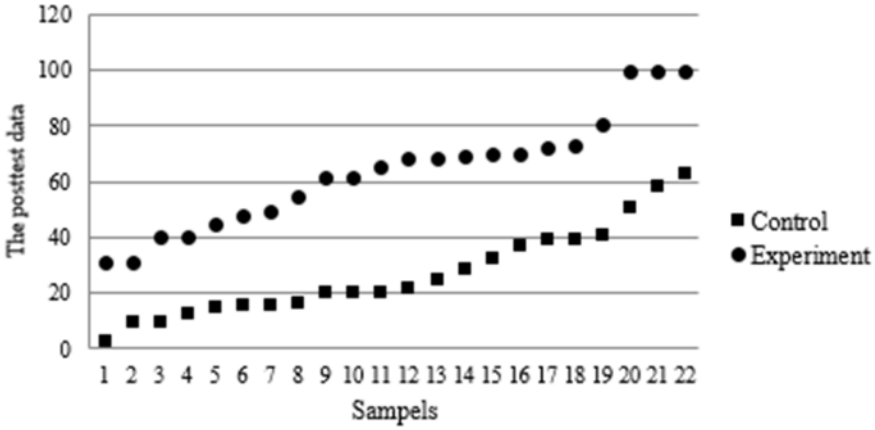

Figure 3. Distribution of the posttest data in control class and experiment class.

3.2. Teacher's Responses and Student's Responses to Learning Using Project Based Student worksheet

The percentage of teacher's responses and student's responses to learning using project based student worksheet can be seen in Table 4.

Table 4. Percentage of teachers' responses and student's responses to learning using project based student worksheet.

No	Responses:	Percentage	Category
1.	Teachers	100 %	Very high
2.	students	100 %	Very high

Based on Table 4, it was known that the teacher gives good responses when asked to observe the learning process using project based student worksheet. All the teachers agreed that during learning using project based student worksheet, students were excited and didn't get bored quickly, students often interact with other students, teachers, and learning resources. Learning using project based student worksheet enables students to more actively asked questions in the learning process, enables students to cooperate with friends in learning, tried students to come up with ideas/concept related to mixture separation and make students explore to find a concept/information and give a conclusion. Furthermore, all teachers also agreed that the using of project based student worksheet make learning students centered.

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3.3. Improving Creative Thinking Skills on Fluency Aspects

Fluency refers to the ability to generate a number of questions on emerging issues [19]. In project based student worksheet, the creative thinking skill of the fluency aspect was trained on the activities of "determining fundamental questions". In these activities, teachers begin learning by presenting the phenomena/problems that occur in daily life. Project based learning involves students in problem solving and emphasizes real life so that it had its own challenges for students [20]. The first project, the filtration topic, the teacher presented the problem of using dirty and turbid river water in Muaradua District for consumption such as bathing, washing and cooking.

When writing the problem, the ability to ignite the question of problems that arise (fluency) can be maximized. The creativity is a sensitive thinking process, a process of identifying problems [21]. Figure 4, Figure 5 and Figure 6 are examples of problem formulation written by students.

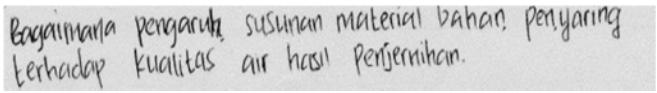

Figure 4. Example of problem formulation written by group 1 on the first project

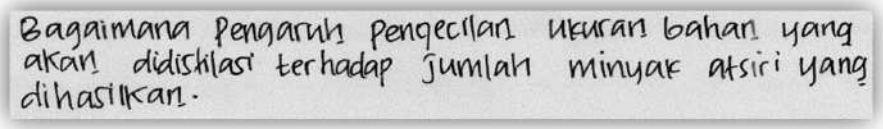

Figure 5. Example of problem formulation written by group 1 on the second project.

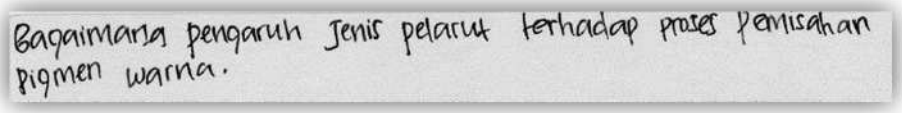

Figure 6. Examples of problem formulas written by group 1 on the third project.

Based on Figure 4, Figure 5 and Figure 6 it was known that the ability to ignite the question of the fluency problem was well trained from project work 1, project 2 to project 3. Students can ignite problems smoothly and well in accordance with the problems presented by teacher. It was evident that project based student worksheet improves the ability to ignite questions on emerging issues (fluency).

3.4. Improving Creative Thinking Skills On Originality Aspects

Creative thinking skills as a skill that using thinking in getting new ideas, new possibilities and new innovation (originality) [22]. Such ideas can also be modifications from ideas that already exist. In project based student worksheet, the skills of generating new ideas/modification ideas from the existing ideas (originality) are trained at the steps "designing project planning". Examples of ideas /concept held by students, in this case is group 4 can be seen in Figure 7, Figure 8 and Figure 9.

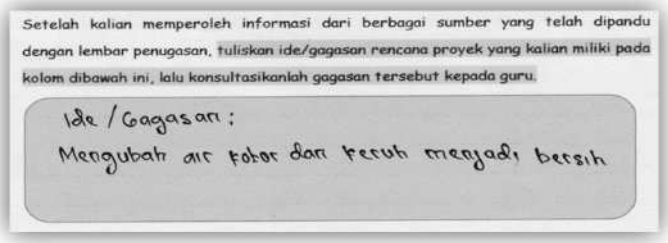

Figure 7. Example of ideas / concept owned by group 4 on the first project.

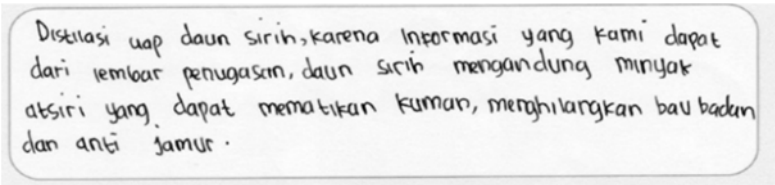

Figure 8. Example of ideas/concept owned by group 4 on the second project

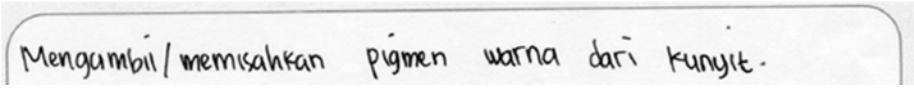

Figure 9. Example of ideas/concept owned by group 4 on the third project

Based on Figure 7, Figure 8 and Figure 9 it can be seen that the students had been able to propose the project idea to solve the problems presented by the teacher in the student worksheet. In the first project (Figure 7), the proposed idea such as treating turbid and dirty water into clean water is correct, although students had not specified what method they would do so. But at least their idea has led to problem solving. Next on the second project (Figure 8), the group of students had specified that they would take betel leaf oil using steam distillation method. In fact, they included reasons that make them want to distill the betel leaf. This showed that they had a new idea/originality that was different from what was exemplified by the teacher was the distillation of citronella oil. Likewise with the idea they proposed on the third project (Figure 9), the idea was a different idea from the example given in the form of beets. They proposed turmeric as a material that can be taken color pigments for natural dye food because they got information when working on the assignment sheet that turmeric contains a color pigment called curcumin.

3.5. Improving Creative Thinking Skills on Elaboration Aspects

Creative thinking skills on elaboration aspect relate to students' ability to refine an idea by adding details that will make the idea become more qualified [21]. In project based student worksheet, creative thinking skills elaboration aspects are trained in project planning activities. In these activities, students were trained to detail project objectives, tools and materials as well as project implementation procedures, project implementation schedules and team members' assignments. The detailing skill is an elaboration skill.

For example, group two, in the first project, the student had not been very clear to write the sequence of the filter material to be arranged in the filtration column from bottom to the top and vice versa although they had sufficiently clear to write that they will do two experiments with each thickness of 5cm And 10 cm. Next on the second project, the students had sufficiently detailed to write down the required materials and project procedures. Students had written in full that they will do two experiments with cut-yelled and unbroken *kenanga* flowers where the number of *kenanga* flowers used in the first and second experiments were the same. But they had not determined the number of

kenanga flowers they would use. In this case when consulted, the teacher provided a stimulus that encourages students to determine the number of *kenanga* flowers they will use.

In the third project, the students' detailing ability was getting better such as detailing the tools and materials with complete and the run down procedure. Even the size of filter paper they would use completely write down. They also understand that they would use the same filter paper for the two experiments that they will do, but they had not mentioned the type of filter paper they would use. So teachers need to provide a back stimulus so when they bought filter paper, in accordance with what they planned. But apart from that, the elaboration ability of students was getting better.

3.6. Improving Creative Thinking Skills on Flexibility Aspects

Flexibility is the ability to adapt, not to remain in its way and can take alternative solutions to problem solving [23]. In project based student worksheet, creative thinking skills in flexibility aspects were trained at the project planning step. At that step, students were asked to define experiment variables tailored to the problem formulation that they had written and also adjusted to the ideas/concept they had proposed in order to solve the problem. When students could determine experiment variables according to the problem formulation and ideas/concept they have, then students were said to have flexibility thinking skills.

At first, especially on the first project (filtration) they were very difficult in determining the variables. Even they do not understand what was meant by independent variables, control variables and dependent variables. So teachers need to guide and direct students to understand the variables. In the project based student worksheet, the definition of independent variables, dependent variables and control variables and examples are intended to facilitate students in understanding the definition of variables. So that students could determine the variable well until the next projects. Generally, students no longer had difficulty when they should determine the variables on the second and third projects.

In the experiment class, n-Gain flexibility aspect were the highest n-Gains compared to n-Gain fluency, originality and elaboration aspect (Figure 2). After been analyzed, from three questions of flexibility (the question of determining experiment variables) presented at the time of pretest, no student can answer the question. All students got a score of 0 for the three questions. This is because students never learned to determine experiment variables. After project based student worksheet was applied, students were trained continuously to be able to determine experiment variables so that students can answer three questions of flexibility (questions about determining experiment variables) presented at the time of posttest well.

4. Conclusion

Based on the results of data analysis, it could be concluded that project based student worksheet can improve the skills of creative thinking well where the average of posttest in the experiment class was higher than the control class. Then there was a significant difference between the average of posttest score of students' creative thinking skill in experiment class and control class with effect size in the large category. Furthermore, teachers and students respond well to learning using project based student worksheet.

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