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# The Effectiveness of Waste Cooking Oil Recycling Project-Based Learning to Improve Students' High Order Thinking Skills

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**ABSTRACT:** This study aimed to describe the effectiveness in project-based learning of waste cooking oil recycling to improve students' high order thinking skills. The research design used was the Matching-Only Pretest-Posttest Control Group Design. The population in this research was all of students in grade XI MIA one of Senior High School in Bandar Lampung. The sample of the research was the students of class XI MIA 4 and XI MIA 6. The data analysis technique used was non parametric statistic test using Mann Whitney U to posttest value. The results of this study it can be seen from posttest value. Posttest value in the experiment class is greater than the posttest value in the control class as well as the <g> on the medium categorized in the experimental class and in the low control class indicate that project-based learning of waste cooking oil recycling can improve students' high order thinking skills.

**Keywords:** high order thinking skills, waste cooking oil, project-based learning

## INTRODUCTION

The era of globalization has given a real influence in various aspects of life. This is marked by the interrelation of science and technology so that the synergy between them becomes faster [1]. In line with the era of globalization, contemporary labor market demands it produces graduates who are able to work in an environment that is constantly changing (ill-defined), the face of non-routine work processes and abstract, taking decisions and responsibility, working in teams [2]. Manpower needs undergo transformation from routine work manually, shifting to non-routine work that requires high order thinking skills [3]. This has resulted in the disappearance of several professions and occupations [4].

This causes the competition to get a job will be intense. Such competition will only be won by qualified and competent humans [5]. Some of the competencies needed in the globalization era include: being able to analyze and solve problems, be able to communicate and cooperate, be able to create and renew, are capable of information technology and communication literacy, and are able to understand and use various communication media to convey various ideas and interact with various parties [6]. These competencies are competencies that are summarized in high order thinking skills [6-9].

The importance of mastering these skills, in order to solve problems, make decisions, and take control of appropriately selected plan [10]. Someone said to have been able to high order thinking when someone associating new information with the information already stored in memory and rearranging and develop information to achieve a goal or to find a solution of a situation that is difficult to resolve [11-12].

One effort to develop these capabilities is through quality education [13-15]. Quality education is an effective means to improve students' high order thinking skills [8, 16]. In the process, high order thinking skills of students can be trained through ill-structured learning. Students are faced with challenging problems in daily life which are presented with high complexity so that various kinds of solutions are brought up [17-18].

One of the challenging problems in real life in everyday life is used cooking oil. Many street vendors use re-cooking oil even though it has been used many times, consequently it will have a negative impact on health [19]. In addition, if dumped into the environment can cause soil and water pollution so that the soil and water ecosystems are disrupted [20].

In solving the problem of waste cooking oil, students are required to be able to express ideas or ideas to solve the problem by making a product. The appropriate learning model for these characteristics is the

project-based learning model (PBP) [21-22]. There are five important features of PBP, namely authentic questions or problems that encourage activities and regulate concepts and principles, group investigations between students as they collaborate on problems, use of cognitive tools, student involvement in investigations, and a series of artifacts or products that answer problem questions [23].

There are several studies related to learning with project-based learning models. Based on the research conducted, it is stated that the project-based learning model has a positive effect on improving student learning achievement on cognitive aspects [24], high order thinking skills of students [25], increasing results student learning in science material [26], improving affective and psychomotor behavior [27], increasing student activities and learning achievement [28], developing students' creative thinking skills [29], improve mastery of students' concepts [30].

However, the facts in the field, namely the nature of chemical learning in schools, learn dead content that is structured and more often emphasizes educational goals in the cognitive realm lower order thinking (cognitive levels 1-3). The learning model applied in the dominant school still uses the conventional teacher-oriented method. As a result, student involvement is minimized so that high order thinking skills are not well developed [31-32]. Therefore, in this article it will be revealed the Effectiveness of the Cooking Oil Recycling Based Learning Model in Improving Students' High Order Thinking Skills.

## METHODS

Control Group as presented in Table 1. In the study two sample classes were determined, class XI MIPA 4 and XI MIPA 6 by purposive sampling. Using lottery, class XI MIPA 6 was used as the experimental class and class XI MIPA 4 was used as the control class.

**TABLE 1.** Research design the matching-only pretest-posttest control group

Research Class	Treatment			
Experimental	M	O	X	O
Control	M	O	C	O

Information:

M = matching, which means there is a match for each class;

O = pretest and post high order thinking skills given;

X = treatment in the form of applying PjBL (Project Based Learning) model;

C = Treatment in the form of application of conventional learning [33]

High order thinking skills of students were measured using a test instrument in the form of an open description question. Data on pretest and posttest scores obtained are converted into values using formulas, that is:

$$x = \frac{\text{score}}{\sum \text{maximum score}} \times 100 \dots \dots (1)$$

Information:

x = value

$\sum$  = total

Then the average pretest and posttest is calculated:

$$\bar{x}_{\text{pre/pos}} = \frac{\sum x_{\text{pre/pos}}}{n} \dots \dots (2)$$

Information:

n = number of students

### Counting of n-gain

From the pretest and posttest scores, the increase is calculated for each student with the normalized gain formula [35]:

$$\langle g \rangle = \frac{\text{posttest score} - \text{pretest score}}{100 - \text{pretest score}} \dots \dots (3)$$

Then the calculation is carried out in each research class using the following formula:

$$\langle \bar{g} \rangle = \frac{\sum \langle g \rangle}{n} \dots \dots (4)$$

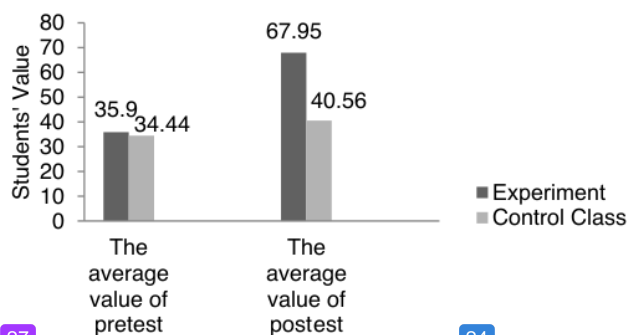
the calculation results are then interpreted using criteria from shown in Table 2.

**TABLE 2.** Criteria <g> [35]

<g>	Category
<g> ≥ 0,7	Height
0,3 ≤ <g> < 0,7	Medium

## RESULT AND DISCUSSION

The results of this study were in the form of pretest and posttest scores related to high-order thinking skills of students. The mean values of pretest and posttest in both experimental and control classes are presented in Figure 1.



**FIGURE 1.** The average value of the pretest and posttest of high-order thinking skills.

Based on Figure 1, the value of the pretest in the experimental class and control did not differ significantly. This is supported by the results of the two-mean test similarity as presented in Table 3.

**TABLE 3.** Average two similarity test results

	Pretest
Mann-Whitney U	286.000
Wilcoxon W	637.000
Z	-1.803
Asymp. Sig. (2-tailed)	.071

Based on the analysis of the similarity test results, the two average values obtained are Asymp. Sig. (2-tailed) > 0.05 which is equal to 0.07 which means that the average pretest value of high order thinking skills of students in the experimental class did not differ significantly from the average pretest scores of students in the control class.

After being given treatment, it turned out that the experimental class posttest value was higher compared to the control class. This is supported based on the results of the two-mean difference test presented in Table 4.

**TABLE 4.** Average two difference test results

	POSTEST
Mann-Whitney U	62.000
Wilcoxon W	527.000
Z	-5.588
Asymp. Sig. (2-tailed)	.000

Based on the test results, the difference in average is obtained by the value of Asymp. Sig. (2-tailed) < 0.05 which is equal to 0.000 which means that the average score of posttest high order thinking skills of students applied to learning with the project based learning model is higher than the average value of post-test high order thinking skills of students with conventional learning. Effective criteria can be shown

using high, medium, and low n-gain averages. The average value of n-gain of students' high order thinking skills is presented in Figure 2.

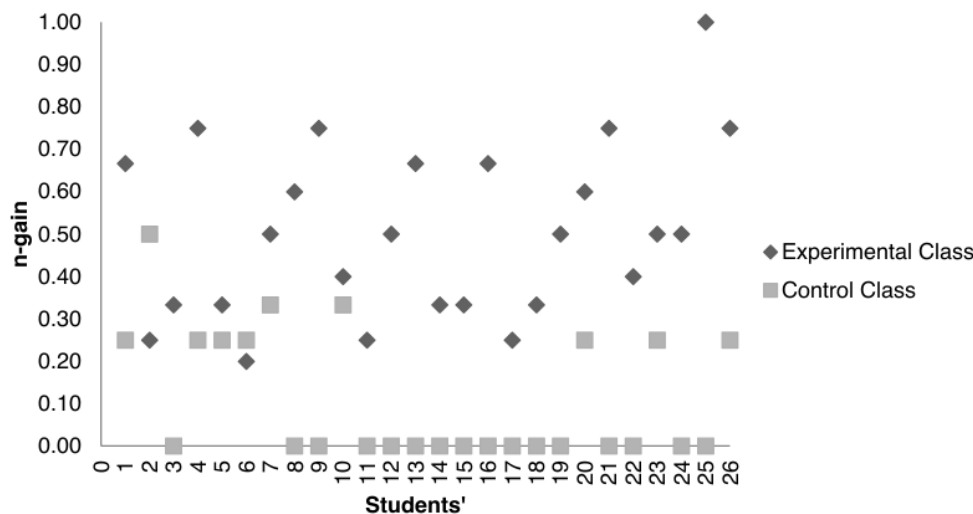


FIGURE 2. The average value of n-gain of students' high order thinking skills

Based on Figure 2, the mean n-gain of high order thinking skills in the experimental class is 0.5, which means medium category, whereas in the control class is 0.8 which means low category. The high n-gain and the category of the experimental class compared to the control class can be explained based on student activities during the activity.

### Stage 1 (essential question)

At this stage the high order thinking skills of students who are trained are analytical skills and creating skills. Someone is said to be skilled in analytical skills when able to distinguish, organize, and give attributes. Someone is said to be skilled in creating when able to generalize, design, produce, and plan again [7, 9].

According to Anderson & Rathwohl, students are asked to have analytic skills if they are able to organize and give attributes. In the learning process, analytical skills can be trained through the stages of orienting students to problems. At this stage, the ability of students is asked to distinguish facts and opinions presented by discourse related to the problem of used cooking oil, then organize the pieces of information, and find the problems that have been presented. However, there are still less skilled students to find the main problem in the discourse. The following are the questions posed by students.

Student 1: "What is used cooking oil?"

Student 2: "What is the harmful content contained in used cooking oil for health?"

Related to the questions presented by students, the teacher informs and gives direction so students are able to formulate questions related to the main problem. Based on the advice given by the teacher the student corrects the question to:

Student 1: "What products can be used using used cooking oil?"

Student 2: "What products can be used using used cooking oil?"

### Stage 2 (design project)

At this stage the high order thinking skills that are trained are the skills of evaluating and creating. Someone is said to be skilled in evaluating when able to check, criticize, hypothesize and experiment [7, 9]. At this stage there are three activities, namely determining information, seeking information, and determining product design. During the process of determining and seeking information, students are asked to write sources of information / references. In this process students are trained to criticize the credibility of information sources. In this process students are trained to criticize the credibility of



information sources. Students only choose information related to used cooking oil content, the danger of used cooking oil for health and the environment based on the literature of a web-blog. However, in consultation and given direction by the teacher, students are able to choose information from the source of the published journal article.

From the information that has been analyzed, then students look for solutions to solve the problem at hand. Students' ability to find solutions is good enough. The solution proposed is in accordance with the problems at hand. In consultation activities, students are trained to conduct an assessment by looking at the negative and positive characteristics of a problem, then assessing whether the proposed solution leads to the effectiveness of the results obtained. At this stage the skills of creating students are trained through the making of a product design that is possible to be made from used cooking oil.

The product design is then communicated and discussed to be agreed upon as a project. By considering the constraints of manufacture, cost and time of manufacture, as well as the tools and materials needed. The agreed product design is solid soap.

### Stage 3 (create schedule)

At this stage, the skills to create students are trained through making timelines and designing projects. In discussion activities, students are trained and guided in planning various methods and solutions for determining the products to be made, then students make a timeline that includes providing tools and materials; doing project; make a report; collect reports and presentations on product results, as well as design projects to solve problems given. This is evidenced by the results of work by students who are increasingly skilled in designing projects as a solution to the problem of used cooking oil.

The skills of creating students are also trained through the manufacture of products and modifying project tools and materials. During the activity students consult with the teacher. In addition, the ability to evaluate students is also trained, this is evidenced by the results of product selection that they will make with various considerations by students. The ability of students to be more skilled in considering the tools and materials used, processing time, and product manufacturing procedures.

### Stage 4 (monitoring the students and progress of project)

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Through the activities of making projects in groups, enthusiastic students to be actively involved in the process of making the project. Students are skilled in making projects, that is, such as preparing appropriate tools and materials, making projects according to procedures and systematically, and using the tools and experimental materials correctly.

### Stage 5 (assess the outcome)

At this stage the skills of students are trained by determining the solid soap from which variants with NaOH are quite dense and have a lot of foam. From the results of the project, all students considered that solid soap with a volume of 15 mL NaOH had these criteria.

### Stage 6 (evaluation the experience)

In the stage of evaluating the experience during the manufacture of the product, the ability of students to discuss the results of the experiment with group members and then present the product results that have been made in the form of reports is good. Furthermore, the ability of students to present the results of experiments in front of the class is still not good. The division to report the results of the experiment is uneven, not all group members are given the opportunity. After being given guidance through consultation activities, presentations are carried out by all group members, so that all students can practice their evaluation skills.

## CONCLUSION

As long as project-based learning takes place, students ask key questions, gather information needed to solve problems, consider the credibility of information sources, make inferences, decide on actions to solve problems, and interact with others. Students have succeeded in making solid soap from used cooking oil to overcome the problems caused by used cooking oil. Based on the average n-gain obtained it can be concluded that the waste cooking oil recycling project based learning model is effective in improving students' high order thinking skills.

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