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Improving Creative Thinking Skills of Junior High School Students through a Project-Based Learning of Cassava Peel Waste Processing

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Abstract: Creative thinking skills have an important role to face the challenges of the 21st century. This study aims to improve the creative thinking skills of junior high school students through a project-based learning model for processing cassava peel waste. This research method is quasi-experimental, non-equivalent pre-test-post-test control group design. The sample in this study was class VII students of SMPN 1 Purbolinggo, who were determined using a purposive sampling technique. The number of students in the control and the experimental classes was 32 people each. The instruments in this research are the Creative Thinking Skills Test and Performance Assessment. The results showed that the average N-gain for creative thinking skills in the experimental class was in the medium category (0.58), while on the control class, it was in the low category (0.29). Cohen's d coefficients for each indicator of creative thinking skills fluency, flexibility, originality, and elaboration; were 0.62, 0.58, 0.72, and 0.72, respectively, all in the medium category. However, Cohen's d coefficient effect size for the average N-gain overall creative thinking skills is 2.40, belonging to the very large category. Based on these results, it can conclude that the project-based learning model is effective with a very large effect on improving students' creative thinking skills.

Keywords: creative thinking skills, project-based learning models, cassava peel waste.

Abstrak: *Keterampilan berpikir kreatif adalah penting untuk menghadapi tantangan Abad 21. Penelitian ini bertujuan untuk meningkatkan keterampilan berpikir kreatif siswa SMP melalui model pembelajaran berbasis proyek pengolahan limbah kulit singkong. Metode penelitian ini adalah kuasi eksperimen dengan desain the matching only pretest-posttest control group. Sampel dalam penelitian ini yaitu kelas VII SMPN 1 Purbolinggo. Penentuan sampel menggunakan teknik puposive sampling. Jumlah siswa pada kelas kontrol dan kelas eksperimen masing-masing sebanyak 32 orang. Instrumen dalam penelitian ini adalah Tes Keterampilan Berpikir Kreatif dan Instrumen Asesmen Kinerja. Hasil penelitian menunjukkan bahwa rata-rata N-gain keterampilan berpikir kreatif pada kelas eksperimen berada pada kategori sedang (0,58), sedangkan pada kelas kontrol berada pada kategori rendah (0,29). Koefisien d Cohen untuk masing-masing indikator keterampilan berpikir kreatif kelancaran, keluwesan, orisinalitas, dan elaborasi; berturut-turut adalah 0,62, 0,58, 0,72, dan 0,72 yang semuanya termasuk dalam kategori sedang. Namun, ukuran efek koefisien d Cohen untuk rata-rata N-gain keterampilan berpikir kreatif secara keseluruhan adalah 2,40, termasuk dalam kategori sangat besar. Berdasarkan hasil tersebut dapat disimpulkan bahwa model pembelajaran berbasis proyek efektif dengan pengaruh yang sangat besar terhadap peningkatan keterampilan berpikir kreatif siswa. Hal ini menggambarkan bahwa pengaruh yang sangat besar dari penerapan model pembelajaran berbasis proyek pengolahan limbah kulit singkong adalah pada sinergi keseluruhan indikator kemampuan berpikir kreatif, bukan pada bagian-bagian yang terpisah-pisah.*

Kata kunci: *keterampilan berpikir kreatif, pembelajaran berbasis proyek, limbah kulit singkong.*

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▪ INTRODUCTION

Creative thinking skills important to be trained so that students can solve problems (Trianggono, 2017; Sambada, 2012; Coughlan, 2007; Mihardi, et al., 2013; Bacanli, et al., 2011). Every school wants its graduates to have creative thinking skills because they will be better able to respond to changes and be able to face the challenges of the 21st century. They will be able to contribute positively to society when they grow up. Creative thinking is a skill to develop, find, or create new constructive combinations based on existing data, information, or elements, with different perspectives, which appear as manifestations of perceived problems, thus producing useful solutions. (Diawati, et al. 2017; Syahrir, 2016).

Although creative thinking skills are important for education and professional achievement, the classroom usually provides few opportunities for students to think creatively. However, creative thinking and problem-solving can built into learning in many ways. Many researchers believe, and in some cases prove that every individual can think creatively, at least in certain contexts (Gregory, Hardiman, Yarmolinskaya, Rinne & Limb, 2013; Kaufman & Beghetto, 2009). If the ability to be creative is important for learner success, educators must explicitly encourage and teach it in the classroom (Gregory, Hardiman, Yarmolinskaya, Rinne & Limb, 2013).

Creative thinking skills can be seen in the way students solve a problem. Al-Suleiman (2009) states four indicators of creative thinking skills, namely fluency thinking, flexibility thinking, originality thinking, and elaboration thinking. Originality refers to new ideas generated by a creative person in generating unfamiliar, non-contradictory, and concurrently acceptable responses with a tendency to provide broad associations of ideas. Fluency is the ability to produce a large number of ideas, regardless of their quality. What matters here is the number of responses and ideas rather than single words. Flexibility consists of two kinds, namely, spontaneous flexibility and adaptive flexibility. Spontaneous flexibility is the ability to produce a diversified cluster of thoughts free of dormancy and inertia. Adaptive flexibility is the ability to facilitate problem solving becomes more obvious when the problem requires an extraordinary solution. Elaboration is the ability to add details and meanings to original solutions and thoughts. Indicators of creative thinking skills in science learning can be trained by involving students in solving real problems in the form of projects (Cheng, 2010; Diawati et al, 2017).

Project-based learning (PBL) allows students to use their knowledge to solve real problems in the form of projects (Bilgin, 2015). This learning model involves students in complex problems, and problems in the real world require students to carry out an investigation process and requires students to find solutions to the problem they face in project work. PBL is curriculum-based contextual learning based on challenging real questions or problems, involving students in choosing a topic, considering approaches, designing, solving problems, making decisions, providing opportunities to work independently for a long time, and producing real products related to problems (Diawati, et al. 2017). PBL can improve higher-order thinking skills, including creative thinking skills (Bell, 2010; Kokotsaki, 2016; Diawati et al, 2017; Pramudita, 2018).

Based on its features, the Project-Based Learning Model has basic features, namely the existence of: authentic content and assessment; facilitation rather than instruction; cooperative learning and reflection; incorporation of adult skills; use of authentic questions ("directions") that serve to organize and guide instruction; community of inquiry between students, faculty, community members collaboration on questions or problems; society service; multidisciplinary themes; and the use of cognitive tools to investigate and generate artifacts or products that enable learning, applying concepts, presenting knowledge, and receiving continuous feedback (Krajcik et al., 1994; Marx et al., 1994; Moje et al., 2001).

Many research reports examine creative thinking skills, both using the PBL model and using other learning models but do not use the real problem of cassava peel waste. They include solid material elasticity (Batlolona, et. al., 2019), open and interprofessional inquiry-based learning courses (Rodríguez et al., 2019), collaborative learning design with creative solving processes (Wahyu et al., 2016), refining water (Etikasari et al., 2016), computer and network engineering (Lim et al., 2014), authentic learning environment (Yeen-Ju, et. al., 2014), academic achievement (Malik et al., 2017), steam distillation (Diawati et al., 2017), gender (Bart et al., 2015), scientific roles in the Koran (Smit & Maertz, 2017), CTS and domain design (Perry & Karpova, 2017), the effectiveness of creative thinking skills (Pringle & Sowden, 2017), associative and analytic thinking (Yeung et al., 2003).

▪ METHOD

Participants

The population of this study was all the seventh-grade students of SMPN 1 Purbolinggo East Lampung. The sample in this study was two classes, namely one class as the control class and the other as the experimental class. Determination of the research sample using a purposive sampling technique. The number of students in the experimental class and the control class was 32 people each.

Research Design and Procedures

This research method is quasi-experimental, with nonequivalent pre-test-post-test control group design (Fraenkel, Wallen, & Hyun; 2006). In this design, the experimental class applied a project-based learning program for processing cassava peel waste, and in the control class conventional learning was applied, namely, the learning model that is usually applied by the teacher.

Before applying the treatment, the academic abilities of the two sample classes were matched by asking the teacher for consideration. The two research classes were given a pretest, then a draw was made to determine the control class and the experimental class. Furthermore, the experimental class was given PBL treatment of cassava peel processing and in the control class conventional learning was applied. After the two classes applied to learn, a post-test was carried out in both classes.

Instrument

The instruments used in this research are the Creative Thinking Skills Test and Performance Assessment Instruments (Diawati, Fadiawati, Syamsuri, 2021). The creative thinking skills test consists of 5 descriptive questions used to measure students' creative thinking skills before and after the intervention of the project-based learning model. All test items are valid and reliable based on the Product-Moment and the Spearman-Brown correlation calculation. Test items 1, 3, 4, and 5 have very high validity, while test item 2 has moderate validity. The reliability of the test items obtained 0.72 indicates high criteria.

The performance assessment instrument consists of 16 creative thinking skills task items. The highest graded rubric score for each task is 4, and the lowest is 1. The statements displayed in the performance task have been prepared based on Torrance's creative thinking skills framework, namely fluency, flexibility, originality, and elaboration (Torrance, 2000).

Data Analysis

Calculation of the average normalized gain <g> creative thinking skills according to the Hake equation (1998, 1999):

$$<g> = \frac{(\% < S_f > - \% < S_i >)}{(100 - \% < S_i >)}$$

$<g>$ = the average normalized gain
$<S_f>$ = average posttest score
$<S_i>$ = average pretest score

The results of calculating the average n-Gain were then categorized according to Hake (1999), as shown in Table 1.

Tabel 1. Categorization of average n-Gain

<g>	**Category**
$g \geq 0.7$	High
$0.3 \leq g < 0.7$	Medium
$g \leq 0.3$	Low

(Hake, 1998)

RESULT AND DISSCUSSION

The effectiveness of the PBL program for processing cassava peel waste is determined by the average N-gain value of creative thinking skills. The determination of the N-gain value of each student is based on the acquisition of students' pretest and posttest scores in the control class and the experimental class. The results of the calculation of the normalized average N-gain for all indicators of creative thinking skills in the control class and the experimental class are presented in Figure 1.

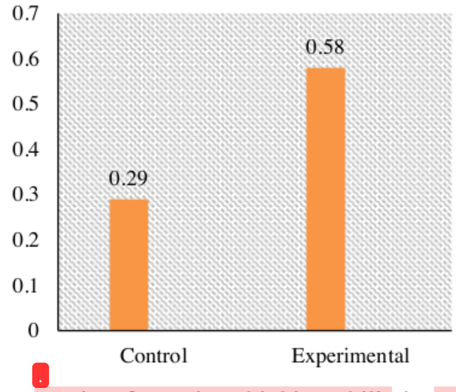

Figure 1. The average n-gain of creative thinking skills in control and experimental classes

This research study is problem-solving creative thinking skills (Diawati, et al. 2017; Syahrir, 2016), which are a synergy of the four indicators, i.e., originality, fluency, flexibility, and elaboration. Based on the average N-gain criteria proposed by Hake (1999), then <g> in the control class is categorized as "low", while in the experimental class it is in the "medium" category. Using the scatter diagram method described the N-gain profile of each student. The scatter diagram for creative thinking skills in the control and experimental classes is shown in Figure 2.

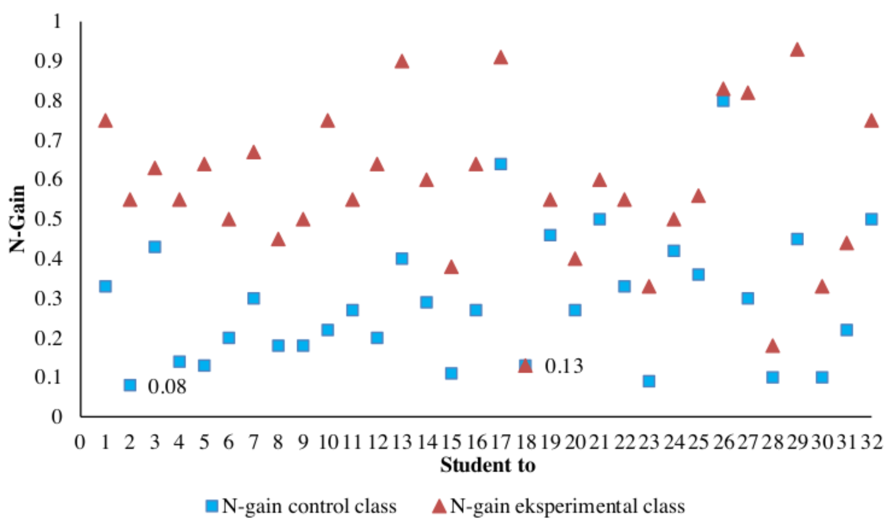

Figure 2. N-gain scatter diagram of students' creative thinking skills

Figure 2 shows that most of the N-gains of creative thinking skills of experimental class students are higher than the N-gains of control class students. However, there are still quite a lot of n-gains of students in the experimental class which are in the same area as the N-gains of control class students on the scatter diagram. Eight experimental class students had high N-gain, while only one student in the control class had a high N-gain. There were still many students in the control class who had low N-gain, namely 19 people, while only two students in the experimental class still had low N-gain. The lowest and highest N-gains in the experimental class were higher than the control class. A comparison of the N-gain profile between the control and the experimental classes shows that PBL processing cassava peel waste is better at increasing students' creative thinking skills.

The descriptive study of the profile of students' creative thinking skills described above shows that the increase in students' creative thinking skills in class applied PBL processing cassava peel waste is higher than in conventional learning. To determine the significance of the difference in the average n-gain creative thinking skills of the students of the two classes, a t-test was performed. The results of the N-gain data normality test for creative thinking ability obtained the χcount value in the control and experimental classes, 7.12 and 5.85, respectively. The null hypothesis (Ho) in this test is that the N-gain data on creative thinking skills comes from a population that is normally distributed. The χtable value at the 95% confidence level ($\alpha = 0.05$) is 7.18; then χcount < χtable so that Ho is accepted which means the research data comes from a normally distributed population.

For the homogeneity test, a two-way (2-tailed) test carried out with a 95% confidence level. The null hypothesis (Ho) for this test is that the N-gain of creative thinking skills between the control class and the experimental class has a homogeneous variance. The results of the N-Gain homogeneity test of students' creative thinking skills obtained the Fcount value1.14. The Ftable value at the 95% confidence level ($\alpha = 0.05$) is 1.89; then Fcount < Ftable so that Ho is accepted, meaning that the average variance of N-gain in both classes is homogeneous.

For the N-gain t-test of creative thinking skills, a one-way (1-tailed) test conducted with the same variance at = 0.05. The null hypothesis (Ho) for this test is that there is no difference in the mean n-gain of creative thinking skills between the control and experimental classes. The test of the difference between the two average values of n-Gain of students' creative thinking skills obtained tcount 4.14 and ttable 1.99, then tcount < ttable. Based on the test, Ho rejected, it means that the average N-gain of creative thinking skills in the experimental class is significantly higher than in the control class.

The t-test provides information on whether there is a significant difference between the control class and the experimental class. However, it does not provide information on how much influence it has on improving creative thinking skills. The effect of the PBL program on the processing of cassava peel waste can determined by calculating the effect size using Cohen's formula. The effect size value is important because it can inform the size of the impact (Sullivan and Fein, 2012). Based on the calculation, the effect size value is 2.40; so it's a very large category. According to Cohen (1998), effect size can be interpreted as the percentage of non-overlapping n-gain groups that receive treatment with groups that do not. Based on the equality between the coefficient d and the percentage of non-overlapping developed by Cohen, the coefficient d = 2,40 means that more than 99.20% Average N-gain for the experimental class is higher than the control class (Cohen, 1998). An illustration for this non-overlapping percentage can be seen in Figure 2. It can concluded that the PBL program for processing cassava peel waste has a very large effect on improving the creative thinking skills of junior high school students.

The average N-gain for each creative thinking skill indicators of originality, fluency, flexibility, and elaboration is presented in Figure 3. The average N-gain for all indicators of creative thinking skills in the experimental class is higher than in the control class. In the experimental class, the average N-gain for all indicators of creative thinking skills are in the medium category. In the control class, the average N-gain elaboration is in the medium category, while the other three indicators are in the low category. This means that the average N-gain for each creative thinking skills indicators in the experimental class are greater than the control class. The biggest difference in N-gain between the control class and the experimental class is the originality (0.41), followed by fluency (0.32), elaboration (0.22), and flexibility (0.22). Based on this analysis can be concluded that the PBL processing cassava peel waste was effective for improving fluency, flexibility, originality, and elaboration skills.

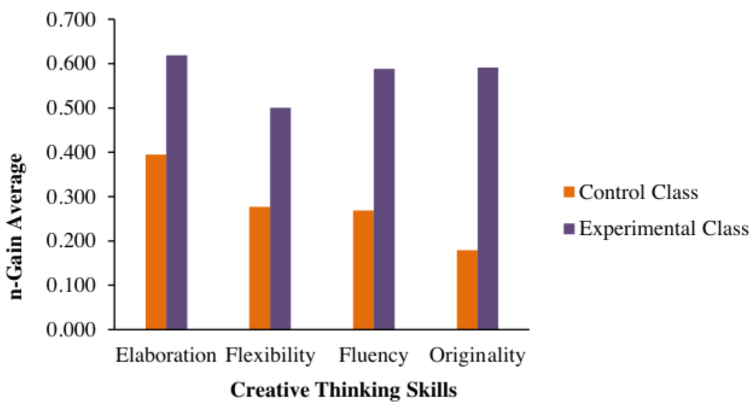

Figure 3. The average N-gain for each creative thinking skill indicators

The question arises: "what is the impact of the PBL model in improving fluency, flexibility, originality, and elaboration skills?" To answer this question, we calculated the effect size of Cohen's coefficient to find out how effective the contribution of the PBL model is. The results of the calculation of Cohen's d coefficient d are shown in Table 2. Based on Table 2, this PBL model has a medium impact on increasing all indicators of creative thinking skills.

Tabel 2. The Effective contribution PBL model for each creative thinking skills indicators

Class	**Creative Thinking Skills**	**N-gain Average**	**Deviation standard**	***d***	**Effect size category**
Control	Fluency	0.13	0.68	0.62	Medium
Experimental		0.51	0.54		

Control	Flexibility	0.09	0.73	0.58	Medium
Experimental		0.46	0.53		
Control	Originality	0.06	0.81	0.72	Medium
Experimental		0.54	0.48		
Control	Elaboration	0.37	0.27	0.72	Medium
Experimental		0.58	0.31		

With Cohen's d of 0.62, it means that 73.2% of the average N-gain on fluency in the experimental class will be above the control class. For Cohen's d 0.58, it means that 71.9% the average N-gain on flexibility in the experimental class is higher than in the control class. Cohen's d value is 0.72, meaning that 76.4% of the average N-gain on originality and elaboration in the experimental class is higher than in the control class. Based on Cohen's d coefficient calculation results, there is a difference in the magnitude of the impact of the PBL model between all creative thinking skills indicators and for each of them. This shows that, although the PBL model effect on each creative thinking skills indicator is in the medium category, the impact on the synergy of all indicators is very large.

The effectiveness of the PBL program in improving creative thinking skills is closely related to the characteristics of the learning process. The PBL process for processing cassava peel waste applied to the experimental class refers to the PBL stages according to Colley Framework (2008). The learning consists of 6 phases, namely orientation, identifying and determining the project, planning the project, implementing the project, documenting and reporting the project, and evaluating and executing the project. The orientation stage carried out in the classroom in the first week. At this stage, the teacher explains the project learning objective, the importance of collaboration, the importance of sharing information, and the expected obligations and roles. Students discuss how they should communicate with each other.

At the stage of identifying the problem, the teacher presents the problem of cassava peel waste in the Purbolinggo District. Furthermore, students were given ill-structured problems through the discourse on cassava peel waste. Through discourse, students identify information/knowledge. The process of identifying problems is guided by a need-to-know worksheet. Students identify the concepts or information mastered, what to look for, and where to look for the information. Mastery of concepts/information is an important prerequisite because it becomes the basis for students to think creatively and innovatively (Diawati, 2017). At this stage, students trained in fluency creative thinking skills, namely the ability to identify a number of relevant information based on problems.

During the planning of a project stage carried out outside the classroom, students must seek information related to the problem from various sources, such as books, articles, and the internet. Students look for information about the content of cassava peels, the processing of cassava peel waste carried out, and what products can make from cassava peel waste. In addition, students also look for tools and materials used in processing cassava peel waste. Students then study the information obtained to develop a project plan. The skill obtained from project-based learning is finding various reading sources (exploring references) and synthesizing various reading sources into the choice of theory needed according to the problem. Students report and discuss the information with the teacher, periodically. During this stage students are trained in fluency, flexibility, originality, and elaboration skills. Students also given the task of writing problem formulations based on discourse (fluency), writing many ideas about projects to solve problems (fluency), proposing ideas about tools and materials that are different from cassava peel waste treatment projects in general (originality), writing project procedures description ideas that are different from cassava peel waste treatment projects in general (elaboration).

Elaboration and originality thinking skills are trained during the project planning stage. During this stage, students were trained to detail project objectives, tools and materials as well as project implementation procedures, project implementation schedules and the tasks of each team member. The detailing skill is an elaboration skill. Project planning activities require students to come up with ideas. Ideas can be modified from existing ideas (originality), so students will be trained to think originality. This is in line with the opinion of Fatmawati, et al (2011) that project-based learning is effective in improving students' creative thinking skills, especially in generating new ideas (originality). The stage of implementing the project carried out outside the classroom. During this stage students prepare tools and materials, assemble tools, and conduct experiments on processing cassava peel waste. Students also detail the obstacles encountered during the experiment. So, in this stage students are trained in originality skills. During the project reporting phase, students prepare a project report. Students write about the idea of solving environmental pollution problems by processing cassava peel waste.

▪ CONCLUSION

The PBL program for processing cassava peel waste is effective for improving the creative thinking skills of Class VII students of SMPN 1 Purbolinggo. This is because in the learning process students in groups are fully involved in solving the problem of processing cassava peel waste. Students identify and select the amount of information and knowledge needed from various sources to solve problems. Students must also study various selected information to plan problem solving with teacher direction. Based on a number of proposed problem formulations, students design projects by applying the scientific method. Based on the project design that initiated, students then conducted experiments to answer the problem formulation.

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