



Journal of Educational Sciences

Journal homepage: <https://jes.ejournal.unri.ac.id/index.php/JES>



P-ISSN
2581-1657

E-ISSN
2581-2203

Building Students' Creative Thinking Skills Using Problem-Based Learning in Handling Staple Food Waste

Rista Firdausa Handoyo, Momo Rosbiono, Wahyu Sopandi

Chemistry Education Program, School of Postgraduate Studies, Indonesia University of Education, Bandung, 40154

ARTICLE INFO

Article history:

Received: 01 Oct 2020

Revised: 06 Jan 2021

Accepted: 14 Jan 2021

Published online: 24 Jan 2021

Keywords:

Handling Staple Food Waste
Problem- Based Learning
Students Creative Thinking Skills

ABSTRACT

This study aims to build students' creative thinking skills using problem - based learning in handling staple food waste. The research methods are development and research with the stages of design, development, and evaluation. This research was conducted at a private high school in Tangerang Regency. The research was involved thirty students of Class XI IPA in the second semester of the 2019/2020 school year and was connected through the WhatsApp group. The research instrument used Student Worksheets (LKS) in the form of a test essay for nine items that have been validated to measure students' creative thinking skills. The research data were analyzed quantitatively by using Microsoft Excel and qualitative-descriptive. The results of the students' creative thinking skills showed the percentage of fluency (31.66%), flexibility (35.18%), elaboration (58.33%), and evaluation (54.88%) indicators, the average percentage was 45.01% categorized as medium. The conclusions drawn are the creative thinking skills that emerge after using problem-based learning are fluent thinking, flexibility thinking, evaluative thinking, and elaborative thinking.

1. Introduction

The Indonesian education system enters the era of the 4.0 generation industrial revolution marked by increased connectivity and creativity (Lase, 2019). Creativity is creating something new that differs from previous thoughts. Creativity describes the attachment between experience and knowledge that generates new thinking in solving the problems at hand (Turkmen & Sertkahya, 2015). Creative thinking is one of the thinking skills, which includes the skills to facilitate the learning process of students in realizing their imaginations, providing opportunities for them to think, express their ideas, and get learning information (Ersoy & Baser, 2014). Creative thinking skills are needed following the

* Corresponding author.

E-mail: ristahandoyo@upi.edu

Doi: <https://doi.org/10.31258/jes.5.1.p.89-103>

increasingly complex problems caused by the rapid development of technology around the world (Ulger, 2018).

The importance of creative thinking, the Indonesian education curriculum emphasizes the need for new learning models that make students actively seek and think creatively. One of the models that the curriculum demands are problem-based learning. The problem-based learning model includes innovative learning, a learning that focuses on student-centered. This means the learning provides more opportunities for students to construct knowledge independently (self-directed) and peer-mediated instruction. Regarding instructional design, the teacher's role is to create and understand innovative learning models (Nurdyansyah & Fahyuni, 2016). Problem-based learning is a learning approach in which students focus to learn about the problems overcome. In such models, students work together to solve a problem, they prepare preliminary knowledge simultaneously by solving the problem they overcome. During a discussion, they formulate a hypothesis, researching and downloading the synthesis of possible solutions to problems they overcome. Reflection, self-assessment, and cooperation are the main components of the problem-based learning process (Charif, 2010).

Problem-based learning in previous studies has not been maximally implemented as the curriculum demands. Teachers have difficulty directing students to make reports about problems that students encounter. Also, teachers have difficulty directing students to complete assignments based on the problems found (Friani, Sulaiman, & Mislinawati, 2017). The problem-based learning process develops students' knowledge that contributes to their learning experience. Every student can think about various solutions that can improve students' creativity level (Iqbal, Yusrizal, & Abidin, 2018). Among the components of creativity, creative thinking skills focus on the cognitive component. Students' creative thinking skills must be emphasized and get attention in the learning process as it will lead to student learning outcomes. The goal of creative thinking skills is to find correct answers, but more than that to develop problem-solving abilities (Yoon, Woo, Treagust, & Chandrasegaran, 2015).

Problem-based learning research has previously shown that the creative thinking skills of students increased significantly with an N-gain of 0.61 in the medium category. This increase occurred because problem-based learning was not designed to help teachers provide as much information as possible to students, but rather to help students develop thinking, problem-solving, and intellectual skills (Wulandari, Liliyasi, & Supriyanti, 2011). Problem-based learning in chemistry learning, the reaction rate material has a good effect on student creativity (Oktaviani, Nurmaliah, & Mahidin, 2017). Laboratory program problem-based learning has a significant effect on the ability of creative thinking of students and statistically showed significant differences in the aspect of fluency, flexibility, originality by Torrance Tests of Creative Thinking (TTCT) (Yoon, Woo, Treagust, & Chandrasegaran, 2015). The problem-based learning model can improve creative thinking skills in environmental chemistry learning with the experimental class N-gain of 0.778, while the control class N-gain is 0.650 (Nuswowati & Taufiq, 2015). The problem-based learning model provides an

increase in students' mastery of chemical concepts, it is seen from the increase in the average posttest score greater than the average pretest score, from 20.1 to 76 (Azizah, Rosbiono, & Sopandi, 2019).

Creative thinking skill is a unique mental process to produce the kind of thinking that is new, different, and original (Herdiawan, Langitasari, & Solfarina, 2019). Creative thinking skills are students' ability to understand a problem and then provide solutions to the problem with various strategies (Kristiani & Muchlis, 2017). Creativity means creating new things. The term creative means that learning is a process of developing student creativity because basically, every individual has a never-ending imagination and curiosity. According to experts, creativity is the ability of a person to give birth to something new or a combination of existing to new ideas (Yuliani, Mariati, Yulianti, & Herianto, 2017).

Students' creative thinking skills in handling staple food waste in SMA have not been maximally achieved, and problem-based learning has not been maximally implemented according to the demands of the curriculum. Therefore, the authors conducted experiment-based research using problem-based learning so that it would improve students' creative thinking skills. This study aims to build students' creative thinking skills using problem-based learning in handling staple food waste and maximizing problem-based learning in meeting curriculum demands. Handling staple food waste makes the students carry out problem-solving activities on how to handle staple food waste into useful products. Students are directly involved in collecting one of the staple food wastes, which is rice to be transformed into a useful product, namely bioethanol with various experimental steps, such as hydrolysis, fermentation, and distillation.

2. Methodology

The research method is development and research with the stages of design, develop, and evaluation. This research was conducted at a private high school in Tangerang Regency. The research involved thirty students of XI IPA Class in the second semester of the 2019/2020 school year who were connected via the WhatsApp group. The instruments were using Student Worksheet (LKS) in the form of a test essay as many as nine items that have been validated to measure students' creative thinking skills. The test instrument is given when the learning process uses problem-based learning which consists of four indicators of creative thinking skills: fluency, flexibility, evaluative, and elaborative. The research data were analyzed quantitatively using Microsoft Excel and qualitative descriptive.

The quantitative analysis calculates the score and percentage of students' creative thinking skills. Students get a different score from each question number. The calculation of the score for creative thinking skills uses a formula as follows:

$$\text{Score} = \frac{\text{Obtained score}}{\text{Maximum score}} \times 100\%$$

Table 1. Score and Category of Creative Thinking Skills

| Score | Category |
|--------|-----------|
| 81-100 | Excellent |
| 61-80 | Good |
| 41-60 | Average |
| 21-40 | Less |
| 0-20 | Very less |

(Arikunto, 2006)

3. Results and Discussion

This study measures the creative thinking skills which are fluency, flexibility, evaluative, and elaborative (Munandar, 2014). Learning activities for handling staple food waste using a problem-based learning model are designed with attention to things that can strengthen creative thinking skills. The learning process is carried out, aiming at students to be able to construct their abilities well through problem-solving, discussion, question and answer, and presentation. The learning process emphasizes how to analyze problems and provide solutions to problems that students find from articles and daily life events. Skills to act creatively are a product of creative thinking skills. Creativity includes some of the skills creativity is required to change concepts, perceptions, or find alternative solutions (Ratnasari, Supriyanti, & Rosbiono, 2017).

Learning handling staple food waste using a model of the problem-based learning is carried out through WhatsApp group and Zoom application due to the pandemic covid -19 (coronavirus disease in 2019) conditions which prohibited face to face learning. The application became a medium for students to discuss, asking and answering, determine problems, analyze problems, solve problems, make experimental reports, and do presentations. Learning materials and learning sources use worksheets to strengthen students' creative thinking skills. Also, teaching materials are derived from optimization results in the lab, experimental video links from YouTube, and learning sources from students' chemistry books. The researcher divided the students into six groups, each group consists of five students. Figure 1 shows the members of groups 1-6.

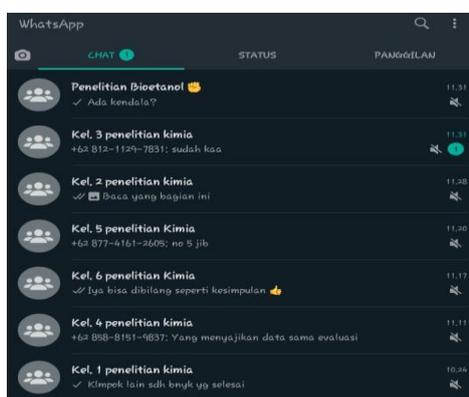


Figure 1. Members group 1-6

Table 2 shows the research data on students' creative thinking skills per sub-indicator in each learning group.

Table 2. The Score of Creative Thinking Skills Obtained by Each Group

| Indicator of Creative Thinking Skills | Sub Indicator of Creative Thinking Skills | Total Score | Group | | | | | |
|---------------------------------------|--|-------------|-------|----|----|----|----|-----|
| | | | 1 | 2 | 3 | 4 | 5 | 6 |
| Fluency | Fluent in expressing the ideas | 6 | 3 | 5 | 1 | 4 | 2 | 2 |
| Fluency | Ask a lot of questions and answer questions according to the number of questions | 12 | 0 | 4 | 4 | 0 | 2 | 2 |
| Evaluative | Analyze problems critically | 3 | 1 | 1 | 0 | 1 | 2 | 3 |
| Elaborative | Perform problem solving in detail and in more depth | 2 | 1 | 2 | 1 | 0 | 1 | 2 |
| Evaluative | Designing an experiment based on ideas | 44 | 30 | 44 | 44 | 19 | 19 | 44 |
| Flexibility | Apply a concept in various ways | 54 | 14 | 22 | 14 | 5 | 5 | 54 |
| Evaluative | Have rational reasons in taking decision | 28 | 8 | 18 | 8 | 2 | 2 | 1 |
| Fluency | Be careful in observing the strengths and weaknesses of a thing | 2 | 1 | 2 | 2 | 0 | 2 | 2 |
| Total | | 151 | 58 | 98 | 74 | 31 | 35 | 110 |

The group which achieved the highest score of creative thinking skills through problem-based learning was group sixth with a score of 110 and the lowest was group fourth with a score of 31. Members of group fourth were constrained by the learning schedule for group discussions. Some students have evening study hours while the others have afternoon study hours. Thus, the discussion is more likely to share tasks instead of solving problems together. Online learning makes it difficult for both teachers and students to apply the stages of problem-based learning. Therefore, the total score obtained from the six study groups is still far from the expected total score of 151. The percentage of indicators of creative thinking skills obtained from all learning groups can be seen in figure 2.

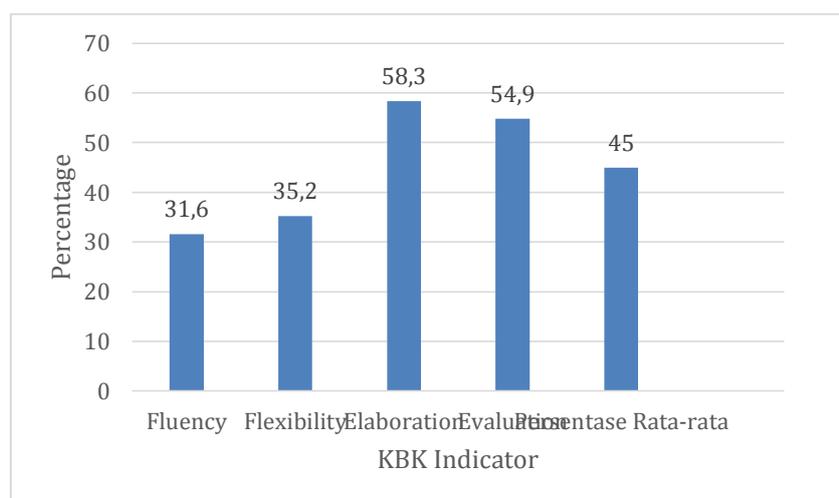


Figure 2. Percentage Diagram of Creative Thinking Skills Indicators

The percentage of indicators for fluently thinking was 31.6%, 35.2% for flexibility in the poor category, 58.3% for elaborative thinking in the sufficient category, and 54.8% for evaluative thinking for the sufficient category. The six groups have constraints on fluency indicator that has the smallest percentage, due to some reasons such as unclear questions, fail to understand what is required on those indicators, lack of discussion between groups, and hesitate to ask the teachers. In the fluency indicator, the researchers asked the students to look directly at the phenomenon of rice waste in the school cafeteria, restaurant, food stall so that triggered students' creativity on how to exploit the wasted rice become a useful thing for everyday life. Students made bioethanol products from raw materials of rice waste taken from leftover rice in the school canteen. This was purposed to reduce rice waste in the environment and the use of alternative fuels that are renewable and environmental-save.

Another relevant study describes that thinking fluently can be trained through the problem-based learning stage, namely orienting students to problems. First, students are asked to observe the phenomena presented by the teacher. Next, they identify the root of the problem by writing down what they know and do not know. The given discourse is a challenging problem that exists in the real world, for example, the river pollution issue caused by bleach waste. Students are asked to read the discourse, then write down what they know and what they do not know from the discourse. Then, the students are trained to write problem formulations based on the given discourse. At this stage, students are asked to discuss with their group members and consult with the teacher, so that the formulation of the problem can result in correct and appropriate (Agustin, Fadiawati, & Diawati, 2018).

The results of the six groups obtained an average percentage of the four indicators of creative thinking skills, where 45 % in the sufficient category. These results seem quite far from expectations because of the limitations of the online learning process. Most of the schools did not encourage their students to extend their thinking to create new ideas and rethink the drawn conclusions. Thus, students'

creative thinking skills need to be improved in the school by giving opportunities for the students to explore their ideas (Abdurrozak, Jayadinata, & Isrok'atun, 2016). Problem-based learning challenges students to solve authentic problems in information-rich settings. They can build solutions that contribute to the most effective experiences such as methods, processes, and disciplines (Birgili, 2015).

This study uses a problem-based learning model in the learning process of handling staple food waste into bioethanol which is integrated with creative thinking skills. Students are divided into six groups, collaborating and discussing in each group by applying the problem-based learning model. The stages itself consist of five stages, which are (1) determining the problem; (2) analysis of learning problems and issues; (3) discovery and reporting; (4) solution presentation and reflection; (5) conclusion and evaluation. The average percentage of the problem-based learning model stages that students received from six groups can be seen in Figure 3. Other studies that use the problem-based learning model emphasize that the problem-based learning model requires students to study actively independently in solving problems, analyzing problems, learning issues, discovery, and reporting experimental results, presentation of solutions, reflection, making conclusions and evaluations (Fahruroji, Kurnia, & Rosbiono, 2016).

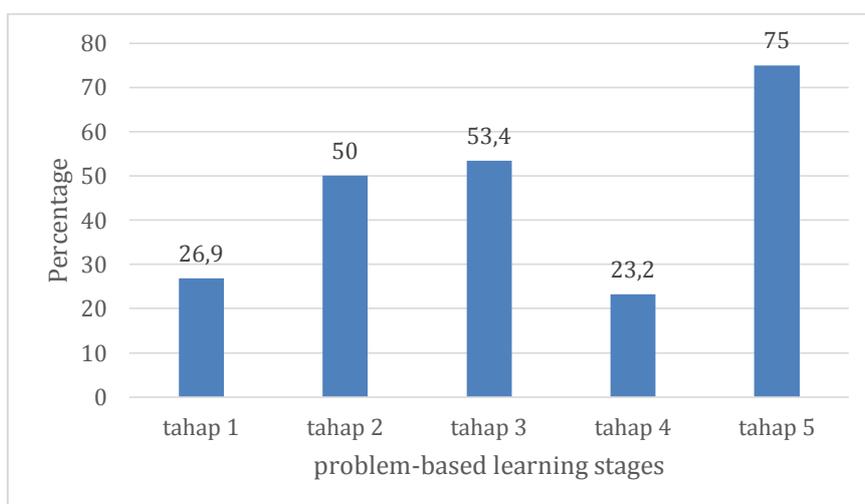


Figure 3. Average Percentage PBL have Obtained Students from 6 Groups

Stage 1 Determining the Problem

Stage 1 of the problem-based learning model is to determine problems regarding staple food waste from the field studies (youtube videos) and determine problems regarding alternative fuels to replace gasoline by reading from articles. Then, students are asked to create questions and answers on their own which makes them easier and according to the problem of field studies and reading articles. Group 1 found the problem from the field study which is " environmental damage and bad smell". The article reading was "increased use of transportation". Meanwhile, in arranging questions and answers, group 1 members did not have

answers which led them to problems on the field studies and reading articles. Thus, Their score on stage 1 was 16,6%. Group 2 data was obtained from the field studies by determining the problem "environmental pollution and stench" and their reading article was "human needs in the 20th century and over ahead will gradually increase, particularly in the transportation field; Indonesia is an oil importer; causes CO2 in the atmosphere ". Meanwhile, in formulating questions and answers, group 2 answers can be seen in Figure 4. Therefore, the group 2 score in stage 1 is 50%.

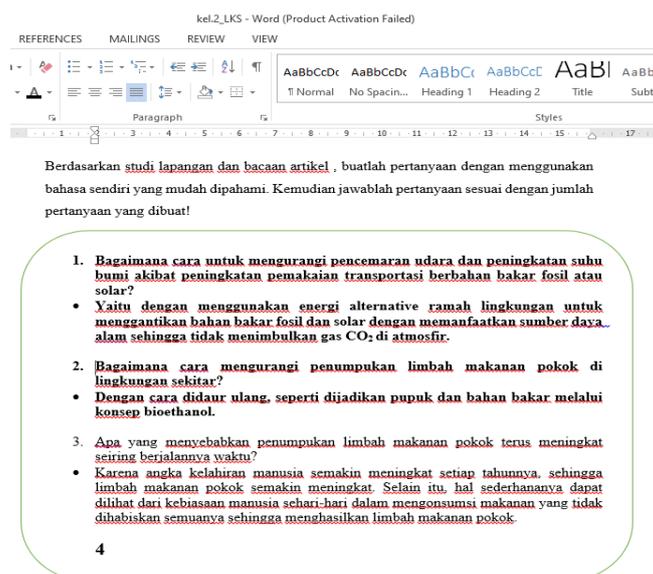


Figure 4. Answer Members Group 2 on Making Questions and Answers

Group 3 did not obtain determining-problem data from the field study, only from the article-reading which is "the increase of vehicle number". Meanwhile, in making questions and answers, members of group 3 have the following data:

Question: "What are the factors causing shortages in fuel?"

Answer: "Increase in the number of vehicles"

Question: "Why alternative energy is needed as a substitute for fuel oil?"

Answer "Because the increasing number of two-or-four-wheel vehicles is directly proportional to the increase of CO₂ emissions"

Thus, the group 3 score in stage 1 is 27,7%.

Group 4 obtained data from a field study with the theme "environmental pollution and damage to its beauty" and the article-reading was "the increase in transportations number and CO₂ gas emissions". Meanwhile, in making questions and answers, members of group 4 do not have the data. Thus, group 4 score at stage 1 is 22, 2%.

Group 5 obtained data from the field study with the theme "causing a bad smell" and from the article reading is "the use of two—or-four-wheel vehicle fuel increases equally as the emission of CO₂". Meanwhile, in making questions and

answers, members of group 5 have data "What is the negative impact of waste on the environment? With an answer causing a foul odor. Thus, group 5 score at stage 1 is 22,2%.

Group 6 obtained data from the field study with the title "causing pollution" and from the article-reading is "the increasing vehicle need for human". Meanwhile, in making questions and answers, members of group 6 have the data "Is it possible for the transportation increase causing pollution? The answer is yes because transportation produces CO₂ gas". Thus, group 6 score at stage 1 is 22,2%.

Stage 2 Analysis of Learning Problems and Issues

Stage 2 of the problem-based learning model is to analyze problems related to the negative impact of staple food waste on the environment and how to solve the problem of staple food waste to prevent negative impact on the environment. Group 1 data analysis of the problem is "rice waste can be dangerous to the environment because there is no special treatment" and data on how to solve the problem of waste is "staple food waste". Thus, the group 1 score in stage 2 was 40%. Group 2 data analysis of the problem was "rice waste cause environmental pollution due to careless throwing garbage" and data on how to solve the problem of waste was "staple food waste was transformed into bioethanol". Thus, the group 2 score in stage 2 was 60%.

Group 3 did not get data analysis because their answers did not focus on problem-analysis related to the negative impact of staple food waste on the environment. Meanwhile, the data on how to overcome the waste problem was "make the waste into biofuel material". Thus, the group 3 score in stage 2 was 20%. Group 4 data analysis was "staple food waste causes bad smell" and there was no data on how to solve the problem of waste. Thus, the group 4 score in stage 2 was 20%.

Group 5 data analysis was "rice waste cause environmental pollution and produce bad smell because carbohydrates produced by bacteria are converted into pyruvic acid" and data on how to solve the problem of waste was "food waste". Thus, the group 5 score in stage 2 was 60%. Group 6 data analysis was "bad smell and taste; bad sight; harm the environment, due to excessive quantity" and data on how to solve the problem of waste was "staple food waste is processed into bioethanol". Thus, the group 6 score in stage 2 was 100%. Other relevant studies on phase 2 problem-based learning model in analyzing and formulating questions step, students will analyze and develop a certain problem of tofu wastewater treatment which will be solved later on. The average score obtained from the six groups was 79.2. It means that students can analyze correctly (Kartamiharja, Sopandi, & Anggraeni, 2020).

Stage 3 Discovery and Reporting

Stage 3 of the problem-based learning model is discovery and reporting. Students are asked to design, conduct experiments, and observe the handling of staple food waste into bioethanol. Then, students make a report to present the experimental

data on the treatment of staple food waste. The findings and reports of this study were the students were asked to make the work steps of the transformation process of rice waste into bioethanol. Then, they must write experimental reports starts from the experiment title; experiment objectives; basic theory; experimental step; Tools and Materials; results of observation and discussion; and conclusion. Group 1 obtained data on designing, conducting experiments, and observing the handling of staple food waste into bioethanol, namely "mentioning the stage of preparation of tools and materials; hydrolysis stage; fermentation stage; the distillation stage" as well as the data making the report "states the title of the experiment; basic theory; observation and discussion of data; conclusion". Thus, the score of group 1 in stage 3 was 44,9%.

Group 2 obtained data on designing, conducting experiments, and observing the handling of staple food waste into bioethanol, namely "mentioning tools and materials; hydrolysis stage; fermentation stage; the distillation stage "as well as the data making the report" mentioning the research title; research purposes; basic theory; results of observation and discussion; conclusion". Thus, the score of group 2 in stage 3 was 67.3%. Group 3 data obtained designing, conducting experiments, and observe the handling of staple food waste into bioethanol was "mentioned preparation tools and materials; hydrolysis stage; fermentation stage; the distillation stage "as well as the data making the report" states the title of the experiment; basic theory; observation and discussion data; conclusion". Thus, the score of members of group 3 at stage 3 was 59, 2 %.

Group 4 obtained data on designing, conducting experiments, and observing the handling of staple food waste into bioethanol, namely "mentioning tools and materials; hydrolysis stage; fermentation stage; the distillation stage ', but the members of group 4 did not mention the working steps of the hydrolysis, fermentation, and distillation stages. Data making of the report was "mentioning the results of the experiment". Thus, the score of group 4 in stage 3 was 24.5%. Group 5 obtained data on designing, conducting experiments, and observing the handling of staple food waste into bioethanol, namely "mentioning tools and materials; hydrolysis stage; fermentation stage; the distillation stage ', but the members of group 5 did not mention the working steps of the hydrolysis, fermentation, and distillation stages. Data making the report is "mentioning the results of the experiment". So, the score member group 5 at stage 3 was 24,5%.

Group 6 obtained data on designing, conducting experiments, and observing the handling of staple food waste into bioethanol is "mentioning the stage of preparation of tools and materials; hydrolysis stage; fermentation stage; the distillation stage "as well as the data making the report" states the title of the experiment; experiment objectives; basic theory; results of observation and discussion; conclusion". Thus, the score of group 6 members in stage 3 was 100%.

Stage 4 Solution presentation and reflection

Stage 4 of the problem-based learning model is the presentation of the solution. Students are asked to present the experimental data on the handling of basic food

waste into bioethanol, starting from the title of the experiment, the experiment objectives, the experimental steps, the results of the observation and discussion, the conclusions. The researcher appointed one person in each group to present the observation report. Presentation materials proposed by group 1 is "bioethanol is an alcohol produced from the fermentation of glucose (sugar) from a source of carbohydrate (starch) biomass with the help of microorganisms. Bioethanol is a type of biofuel (liquid fuel from plant processing) besides biodiesel. Observations made in this practicum went through the hydrolysis, fermentation, and distillation process". Thus, the score of group 1 in stage 4 was 28.6%. The presentation material put forward by group 2 can be seen in Figure 5.



Figure 5. Presentation Material Suggested by Group 2

Thus, the score of group 2 at stage 4 by 64, 3 %.

Presentation materials proposed by a group of 3 was "The observation is conducted in this lab through the process of hydrolysis, fermentation, and distillation processes. Rice waste bioethanol still does not meet the standards, and economically calculation, bioethanol from stale rice waste is not suitable for sale because it is more expensive than bioethanol sold in the market. This is because the manufacture of bioethanol is still on a small scale ". Thus, the group 3 score at stage 4 was 28,6%. The presentation material presented by group 4 was "Basically, everything which is created by Allah SWT, must-have benefits. At first, we thought that food waste had no benefit at all, but if we have the will to find out the benefits then we can make something that seems useless at first will become useful. After answering some of the questions above, it turns out that waste has benefits if we reprocess it, for example, waste can be used as bioethanol". Thus, the score of group 4 in stage 4 was 7,1%.

The presentation material presented by group 5 was "food waste around us can cause a very disturbing odor. If we are aware of and understand how to handle it, we can process another food waste again. There are various ways to treat food waste, such as making bioethanol into fuel". Thus, the score of group 5 in stage 4 was 7,1%. Presentation materials proposed by a group of 6 was " Learn that the waste rice can be used as a substitute fuel which is more efficient and environmentally friendly". Thus, the score of group 6 at stage 4 by 3, 6 %.

Stage 5 Conclusion and Evaluation

Stage 5 of the problem-based learning model is making conclusions and evaluations as a reflection of the knowledge obtained during the learning process. Students are asked to make conclusions and evaluate the reliability of solving the problem of handling staple food waste. The conclusion and evaluation stated by group 1 were "solving the problem of staple food waste that can be done by the government, namely: formulating policies, planning and carrying out source separation and waste reduction, as well as building and managing waste handling facilities". Thus, the group 1 score at stage 5 is 50%. The conclusion and evaluation stated by group 2 is "staple food waste such as rice can be processed into environmental-safe alternative fuels, namely bioethanol and can reduce staple food waste". Thus, the group 2 score in stage 5 is 100%.

The conclusion and evaluation stated by group 3 are "how the use of staple food waste can be used for biofuels". Thus, the group 3 score in stage 5 is 100%. The conclusion and evaluation stated by group 4 are "we have to pay more attention to the environment, find new useful things for the future". Thus, the group 4 score in stage 5 is 0%. The conclusions and evaluations stated by group 5 are "there are so many ways we can do to reduce food waste, such as processing leftover rice into bioethanol". Thus, the group 5 score in stage 5 is 100%.

The conclusion and proposed evaluation of six groups are" Learn that the waste rice can be used as a substitute fuel which is more efficient and environmentally friendly". Thus, the group 6 score in stage 5 is 100%. Table 3 shows the data for the six groups at stages 1-5.

Table 3. Data for 6 Groups at Step 1-5

| Stage 1 PBL | Group | | | | | |
|--|--------------|----------|----------|----------|----------|----------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Determine the problem of field study | 2 | 2 | 0 | 2 | 1 | 1 |
| Determine the problem of reading the article | 1 | 3 | 1 | 2 | 1 | 1 |
| Create questions and answers | 0 | 4 | 4 | 0 | 2 | 2 |
| amount | 3 | 9 | 5 | 4 | 4 | 4 |
| Score (%) | 16.6 | 50 | 27.7 | 22.2 | 22.2 | 22.2 |

Stage 2 PBL

Group

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---------------------------|----------|----------|----------|----------|----------|----------|
| Analyze the problem | 1 | 1 | 0 | 1 | 2 | 3 |
| Solving problem | 1 | 2 | 1 | 0 | 1 | 2 |
| Total | 2 | 3 | 1 | 1 | 3 | 5 |
| Score (%) | 40 | 60 | 20 | 20 | 60 | 100 |
| Group | | | | | | |
| Stage 3 PBL | 1 | 2 | 3 | 4 | 5 | 6 |
| Designing experiments | 30 | 44 | 44 | 19 | 19 | 44 |
| Make a report | 14 | 22 | 14 | 5 | 5 | 54 |
| Total | 44 | 66 | 58 | 24 | 24 | 98 |
| Score (%) | 44.9 | 67.3 | 59.2 | 24.5 | 24.5 | 100 |
| Group | | | | | | |
| Stage 4 PBL | 1 | 2 | 3 | 4 | 5 | 6 |
| Presentation | 8 | 18 | 8 | 2 | 2 | 1 |
| Total | 8 | 18 | 8 | 2 | 2 | 1 |
| Score (%) | 28.6 | 64.3 | 28.6 | 7,1 | 7,1 | 3,6 |
| Group | | | | | | |
| Stage 5 PBL | 1 | 2 | 3 | 4 | 5 | 6 |
| Conclusion and evaluation | 1 | 2 | 2 | 0 | 2 | 2 |
| Total | 1 | 2 | 2 | 0 | 2 | 2 |
| Score (%) | 50 | 100 | 100 | 0 | 100 | 100 |

4. Conclusion

Based on the results of data analysis and discussion, it can be concluded that the creative thinking skills of the students which are triggered by using the model of problem-based learning are fluency, flexibility, elaboration, and evaluation. The problem-based learning model is suitable for use in real laboratory experiments in the situation without Covid -19 pandemic.

Acknowledgement

I would like to thank the eleventh-grade teacher who participated in this study, the thesis supervisor, and my family for their motivation.

References

- Abdurrozak, R., Jayadinata, A. K., & Isrok'atun. (2016). Pengaruh model problem-based learning terhadap kemampuan berpikir kreatif siswa. *Jurnal Pena Ilmiah*, 1(1), 871-880.
- Agustin, S., Fadiawati, N., & Diawati, C. (2018). Efektivitas pembelajaran berbasis masalah pencemaran limbah pemutih dalam meningkatkan

-
- keterampilan berpikir kreatif. *Jurnal Pendidikan dan Pembelajaran Kimia*, 7(2), 1-12.
- Arikunto, S. (2006). *Dasar-dasar evaluasi pendidikan*. Jakarta: Bumi Aksara.
- Azizah, F. N., Rosbiono, M., & Sopandi, W. (2019). Kontribusi tindakan kreatif pada penguasaan konsep siswa melalui problem-based learning pada konteks pengawetan apel. *Jurnal Pendidikan Kimia Undiksha*, 3(1), 9-19.
- Birgili, B. (2015). Creative and critical thinking skills in problem-based learning environments. *Journal of Gifted Education and Creativity*, 2(2), 71-80.
- Charif, M. (2010). *The effects of problem-based learning in chemistry education on middle school students' academic achievement and attitude*. Amerika: Lebanese American University.
- Ersoy, E., & Baser, N. (2014). The effects of problem-based learning method in higher education on creative thinking. *Procedia-Social and Behavioral Sciences*, 116, 3494-3498.
- Fahrurroji, T., Kurnia., & Rosbiono, M. (2016). Penerapan pembelajaran berbasis masalah untuk meningkatkan kemampuan kognitif dan kreativitas siswa pada topik biogas. *Jurnal Ilmu Pendidikan dan Pengajaran*, 3(3), 234-242.
- Friani, I. F., Sulaiman., & Mislinawati. (2017). Kendala guru dalam menerapkan model pembelajaran pada pembelajaran tematik berdasarkan kurikulum 2013 di SD Negeri 2 Kota Banda Aceh. *Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, 2(1), 88-97.
- Herdiawan, H., Langitasari, I., & Solfarina. (2019). Penerapan PBL untuk meningkatkan keterampilan berpikir kreatif siswa pada konsep koloid. *Jurnal Kimia dan Pendidikan*, 4(1), 24-35.
- Iqbal, M., Yusrizal., & Abidin, Z. (2018). The development of learning instruments through the problem-based learning model to enhance students' creativity. *Journal of Physics*, 1088, 1-6.
- Kartamiharja, M. R., Sopandi, W., & Anggraeni, D. (2020). Implementation of problem-based learning (PBL) approach in chemistry instructional with context of tofu liquid waste treatment. *International Journal of Learning, Teaching and Educational Research*, 19(5), 47-77.
- Kristiani, S. U. Y., & Muchlis. (2017). Penerapan model pembelajaran inkuiri terbimbing pada materi kesetimbangan kimia untuk melatih keterampilan berpikir kreatif siswa kelas XI SMA Negeri 12 Surabaya. *Journal of Chemical Education*, 6(2), 202-207.
- Lase, D. (2019). Pendidikan di era revolusi industri 4.0. *Jurnal Sundermann*, 1(1), 28-43.
- Munandar, U. (2014). *Pengembangan kreativitas anak berbakat*. Jakarta: Rineka Cipta.
- Nurdyansyah., & Fahyuni, E. F. (2016). *Inovasi model pembelajaran sesuai kurikulum 2013*. Sidoarjo: Nizamial Learning Center.
- Nuswowati, M., & Taufiq, M. (2015). Developing creative thinking skills and creative attitude through problem-based green vision chemistry environment learning. *Jurnal Pendidikan IPA Indonesia*, 4(2), 170-176.
- Oktaviani, C., Nurmaliah, C., & Mahidin. (2017). Implementasi model problem-based learning terhadap kreativitas peserta didik pada materi laju reaksi di SMAN 4 Banda Aceh. *Jurnal Pendidikan Sains Indonesia*, 5(1), 12-19.
-

-
- Ratnasari, D., Supriyanti, T., & Rosbiono, M. (2017). Vocational high school students' creativity in food additives with problem-based learning approach. *International Conference on Mathematics and Science Education*, 895.
- Richey, R. C., Klein, J. D., & Nelson, W. A. (2015). *Developmental research studies of instructional design and development*. ResearchGate.
- Turkmen, H., & Sertkahya, M. (2015). Creative thinking skills analyzes of vocational high school students. *Journal of Educational and Instructional Studies in the World*, 5(1), 74-84.
- Ulger, K. (2018). The effect of problem-based learning on the creative thinking and critical thinking disposition of students in visual arts education. *Interdisciplinary Journal of Problem-Based Learning*, 12(1), 1-21.
- Wulandari, W., Liliyasi., & Supriyanti, T. (2011). Problem-based learning untuk meningkatkan keterampilan berpikir kreatif dan penguasaan konsep siswa pada materi larutan penyangga. *Jurnal Pengajaran MIPA*, 16(2), 116-121.
- Yoon, H., Woo, A. J., Treagust, D. F., & Chandrasegaran, A. L. (2015). Second-year college students' scientific attitudes and creative thinking ability influence of a problem-based learning (PBL) chemistry laboratory course. *Affective Dimensions in Chemistry Education*, 217-233.
- Yuliani, H., Mariati., Yulianti, R., & Herianto, C. (2017). Keterampilan berpikir kreatif pada siswa sekolah menengah di palangkaraya menggunakan pendekatan saintifik. *Jurnal Pendidikan Fisika dan Keilmuan (JPFK)*, 3(1), 48-56.

How to cite this article:

Handoyo, R. F., Rosbiono, M., & Sopandi, W. (2021). Building Students' Creative Thinking Skills Using Problem- Based Learning in Handling Staple Food Waste. *Journal of Educational Sciences*, 5(1), 89-103.
