Improving problems solving skills through problem-based learning of oil palm empty fruit bunch waste in science learning for students at SMAN 1 Muara Badak

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ABSTRACT

Problem-solving skills need to be provided to students so that they can play a role in overcoming environmental problems in everyday life. This study aims to determine the effect of problem-based learning in science learning on the topic of empty oil palm bunches waste to improve students' ability to solve problems. This research is quantitative research with a pre-experimental method. The research design used is a one-group pretest-posttest design with five replications. The samples in this study were students of SMAN 1 Muara Badak in grade 10^{th}. Data collection used tests in the form of pre-tests and post-tests. Data analysis used the N-Gain Test. The results showed an increase in problem-solving skills in the good category. Thus, it can be concluded that problem-based learning of oil palm empty fruit bunches waste in science learning can improve students' skills to solve environmental problems in everyday life.

Keyword: oil palm empty fruit bunches waste, science learning, problem solving skill.

INTRODUCTION

The current Merdeka Curriculum aims to create a golden generation that is globally competitive. This curriculum is designed to equip students with relevant 21st-century skills where technology and information continue to develop rapidly (Hanipah, 2023). One of the important 21st-century skills provided to students is problem-solving skills, because students will always face problems in their daily lives. Real-life problems are complex so that they cannot be solved by just one subject studied in school. Therefore, in the Merdeka Curriculum, chemistry subjects in phase E are no longer studied separately but are taught in an integrated manner with Physics and Biology subjects, with a focus on essential materials. In the Merdeka curriculum, teachers are given the freedom to teach the material in depth, so that students can think critically, collaborate, and solve problems.

In the implementation of the Independent Curriculum, the Problem-Based Learning (PBL) Model is one of the learning models that aims to improve students' problem-solving skills. The PBL model can be applied at various levels of education, from secondary to tertiary level. In the PBL model, students are invited to solve real-world problems that are relevant to the subject matter. Thus, students can develop critical thinking skills, collaborate, and make the right decisions. One of the topics of material in the science subject in phase E that is closely related to problems in everyday life is the topic of green chemistry. Green chemistry studies various chemical processes and products that are environmentally friendly and support sustainable

development (Prabawati & Wijayanto, 2015). Green chemistry also emphasizes the efficient use of natural resources to improve the environment and encourage a sustainable lifestyle (Kenneth & James, 2004).

Learning material on green chemistry can be linked to the problem of oil palm empty fruit bunches (OPEFBs) waste faced by the palm oil industry in several provinces in Indonesia, because Indonesia is the largest palm oil producer in the world. OPEFBs waste is the largest solid waste produced in the palm oil processing industry. Until now, OPEFB waste has only been left to pile up and has not been utilized optimally in several regions in Indonesia, especially in the province of East Kalimantan. This is due to the lack of knowledge and awareness of the community around the factory about the utilization and processing of empty oil palm bunch waste.

The abundance of OPEFBs waste around the palm oil processing factory area can be used as a topic in problem-based science learning at the 10th grade of high school. Through the orientation of problems about the abundance of empty oil palm bunches in the problem-based learning model, it is hoped that students can have the ability to solve problems, especially those related to practical problems that require economically feasible solutions, on time, and considerations of whether or not the solution can be implemented in real life (Rahayu, 2019).

Schools reflect the larger society and the classroom is a laboratory for solving real-life problems (Rahayu, 2019). Therefore, problem-based learning that orients the problem of OPEFB waste is expected to encourage students to engage in problem-oriented projects or assignments and help them investigate intellectual and social issues, making science learning in schools more meaningful. With this PBL model, students not only learn the concepts of science and technology, but are also actively involved in finding solutions to real problems. This kind of learning is expected to improve their ability to solve problems, as well as provide a positive impact on the surrounding environment.

METHOD

This type of research is a quantitative research with *a pre-experimental* method that aims to determine the influence of problem-based learning model in science learning on the topic of green chemistry in improving students' problem solving skills. This study uses *a one group pretest-posttest design*. This design involves five groups which are given pretest to measure students' problem solving skills before being given treatment, and then the students in each groups were treated with a problem-based learning model with the orientation of problems relating to the OPEFBs waste. After treatment, all students in each group are given posttest to measure the problem solving skills. The population in this study is all students in grade 10th at

SMAN 1 Muara Badak, with a total of 156 students divided into 5 classes (groups). In this research, all populations become samples. The research design scheme was shown in Figure 1.

Pretest	Treatment	Posttest
O_1	X	O_2

Figure 1. Research design scheme

The instrumen used in data collection in this study is a test of science problem-solving ability, consisting four indicators, namely: (1) understanding the problem; (2) planning a solution; (3) implement a problem-solving plan; and (4) looking back the solution. The subject matter of science in this study is "Green Chemistry" in grade 10th of high schools. The data analysis is carried out using N-gain test. A *paired sample t*-test is performed as a prerequisite to ensure that there were significantly different between pretest and posttest results. The consistency of the implementation of PBL models on improving of problem-solving skills for each groups was analyzed using *One Way ANOVA* test.

RESULT AND DISCUSSION

Result

The pretest and posttest results of problem-solving skills of students grade 10th at SMAN 1 Muara Badak obtained in this study are presented in Figure 2. Based on Figure 2, the average *post-test* score of students' problem-solving skills for each groups are greater than the *pretest score.*

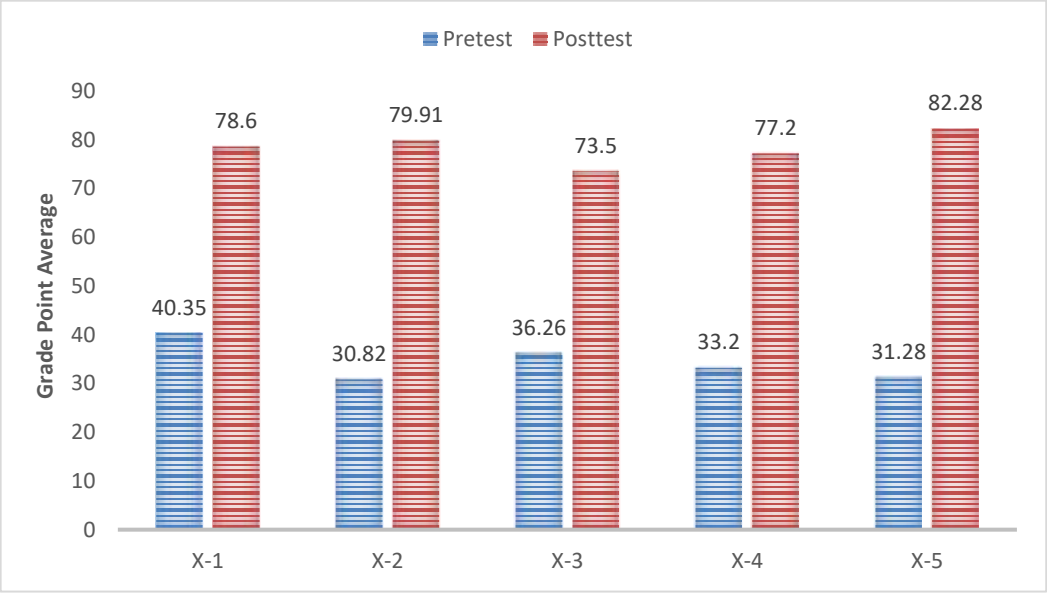

Figure 2. Average pretest and posttes*t* scores

To ensure that the pretest and posttest scores in each groups are significantly different, the *paired sample t-test* were conducted. Based on Table 1, it can be known that the value (sig.) of all groups were lower than 0.05. It is concluded that the pretest and posttest results of all groups are significantly different. With the fulfillment of prerequisite test, namely *t*-test, the further data analysis using N-gain test can be perfomed.

Table 1. *T-test results*

Groups	***t-test***		
	n	Df	Sig.
X-1	28	27	0,000
X-2	35	34	0,000
X-3	34	33	0,000
X-4	34	33	0,000
X-5	25	24	0,000

The N-gain test was carried out to determine the magnitude of the increase in students' problem-solving skills using pretest and posttest data. The N-gain test results for each groups can be seen in Table 2. The N-gain results for each groups showed the value of > 0.7. This indicated that the magnitude of the increase in students' problem-solving skills is in the high category. The one way ANOVA test results showed that the significant value (sig.) of 0.075 > 0.05 indicating that the treatment of problem-based learning model with the problem orientation about OPEFBs waste are consistent in improving problem-solving skills for each groups.

Table 2. N-gain test

Group	***N-gain***	**Category**
X 1	0,7616	High
X 2	0,7886	High
X 3	0,7662	High
X 4	0,7572	High
X 5	0,8007	High

Discussion

Based on the results of data analysis, there are an increasing of students' problem-solving skills after treatment using PBBL models with problem orientation about OPEFBs waste. This is due to the problem orientation in PBL models is real-life problems around students. The syntax of problem orientation about OPEFBs waste is able to encourage students to build a deeper understanding of science concepts contextually through a series of constructive questions that they must resolve (Salim et al., 2024; Suswati, 2021). In line with Temel (2014)

that the PBL model is designed to help students acquire important knowledge that improves their skills in solving problems.

The improvement of students' ability to identify problems can be explained by the application of the PBL model that uses real-life problems as a learning context. Problems that are relevant to daily life make it easier for students to understand the problem and be better prepared to solve it. This is in accordance with Aprina et al. (2024) which stated that the PBL model uses real-world problems to develop critical thinking skills and solve problems. By orienting students to the problem, they are introduced to the context and the problem in detail, which helps them to analyze different aspects of the problem. The problem understanding indicator is a tool to assess the extent to which students can grasp the core of the problem they are facing, including their ability to identify important factors and their relevance. A good understanding of the problem becomes a solid foundation for the next steps in the problem-solving process.

Problem-based learning involves students in a structured learning process, where they follow pre-planned stages to reach solutions to the problems they face. This model not only teaches students to design a good problem-solving plan, but also ensures the effective implementation of the plan, resulting in a well-organized learning process and satisfactory results. This is in line with Anisaunnafi'ah (2015) stated that PBL is a learning model allowing students to learn by structuring and solving real problems in a structured manner. Through the PBL model, students are invited to identify problems, plan solution steps, and implement and evaluate the results. This approach not only improves students' critical thinking and problem-solving skills, but also trains them to work together in groups, ultimately strengthening their understanding of the material being studied.

CONCLUSION

The implementation of the problem-based learning model (PBL) with the problem orientation on OPEFBs waste has proven to be effective in improving students' ability to solve problems. The results of *the pretest* and *posttest* tests showed a significant increase, with a relatively high *N-gain* value. The PBL model helps students understand and solve real problems through a structured process, which encourages them to think critically and work together. Therefore, problem-based learning (PBL) can effectively improve students' problem-solving skills.

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