

Project-Based Learning: Chemistry Students' Role in Fostering the Society in Recycling the Waste Cooking Oil

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ABSTRACT: Project-based learning has been used globally as one of the effective methods to evaluate student performance in achieving the learning outcome of the chemistry subject. It became one of the priorities in implementing the new policy, *Merdeka Belajar-Kampus Merdeka (MB-KM)* from The Ministry of Education, Culture, Research and Technology in Indonesia. The student at the university level can join a project-based learning program conducted outside the classroom and supervised by the Project supervisor. We proposed the project-based learning program to maximize the chemistry students' role in solving the waste cooking oil in society. The purpose of this program was to introduce the chemistry student to the real problem in the society and allow the dissemination of their innovative idea. The information prevailed from observing the activity, interviewing the students, and evaluating the student's performance. This project-based learning presented that students accomplish the information and knowledge they gain from the classroom into actions to solve the real problem in society.

Keywords: project-based learning, *Merdeka Belajar-Kampus Merdeka (MB-KM)*, waste cooking oil, chemistry students' role

INTRODUCTION

Learning chemistry in higher education provides many options for the student to choose for the learning style to complete the lecture each semester. The learning process can happen in the classroom, laboratory, society, industry, etc.. The authors use project-based learning to teach the student in the Community Assistance Course registered by the student from multidiscipline [1]. Chemistry Student learn to communicate and collaborate with other students from other study programs to solve the agricultural program in the community and society. They work and live in the community almost 24/7 for 1 month, but we only can recognize the learning activity within 2 credits in the university.

The Ministry of Education, Culture, Research and Technology in Indonesia requests that all higher education institutions implement a new policy, *Merdeka Belajar-Kampus Merdeka (MB-KM)* [2, 3]. It supports the idea for the higher education institution to create an innovative learning culture, not restrain, and match the students' needs. Students freely take the credit outside of the study program, 1 semester take the course outside the study program, and 2 semester do the learning activities outside the university.

Various forms of learning activities outside of tertiary institutions, including internships, implementing community service projects in villages, teaching in educational units, participating in student exchanges,

conducting research, conducting entrepreneurial activities, making studies/projects independent, and participating in humanitarian programs. All these activities must be carried out with the guidance of the lecturer. Independent campuses are expected to be able to provide contextual field experiences that will improve student competence as a whole, and be ready to work or create new jobs [4, 5].

With the current situation, we implement project-based learning with the support of MB-KM to solve a waste cooking oil with chemistry. Previously, we could only recognize the project-based learning in 2 credits, i.e., community assistance subject [1]. With the updated regulation from The Ministry of Education in Indonesia, we can identify the learning activity in some courses up to 20 credits in 1 semester [2]. This regulation supports us as Chemistry Educators in using project-based learning as the learning method and activity option.

Although the student only used 1 project in society or industry, they can earn up to 10 credits from that project. Herein, the task of the Chemistry Educators is to communicate with the study program for conversion and recognition. The conversion and recognition are based on the similarity of the learning outcome of the study program. For good practice, we only convert the project in chemistry topics to the elective course with a similar learning outcome to the activity.

Advanced technology, like virtual classes and laboratories, uses the latest information communication and technology (ICT) to support the learning activity inside and outside the classroom [6, 7]. Student work in the project for the outside classroom activities can maximize the role of ICT to promote the recommendation for solving the problem in the community. The student will learn to use hard and soft skills, encouraging collaboration, creativity, and innovation to negotiate with the community looking for the best solution for the exact problem [8, 9].

The research addressed in this article promotes special project-based learning to support the MB-KM regulation, and it is possible to implement it globally. This effort became the pioneer of the special project-based learning to freely give the students options to study and practice their skills to face real-world problems. The student will act to solve the waste cooking oil in the society and transfer their knowledge in chemistry to help society to implement the green chemistry concept in their daily life. This study will not only contribute to Indonesian students implementing the MB-KM but also to the global student interested in implementing project-based learning.

METHODS

The project was jointed by ten students from several Departmen of Chemistry with minimum 3rd year of the study. The team needs to follow the project regulation before and after implementing the chemistry in the society. The team of students were directed to study the literature regarding the chemical waste management project. Figure 1. describe the step for preparing the project based learning to solve the problem in society.

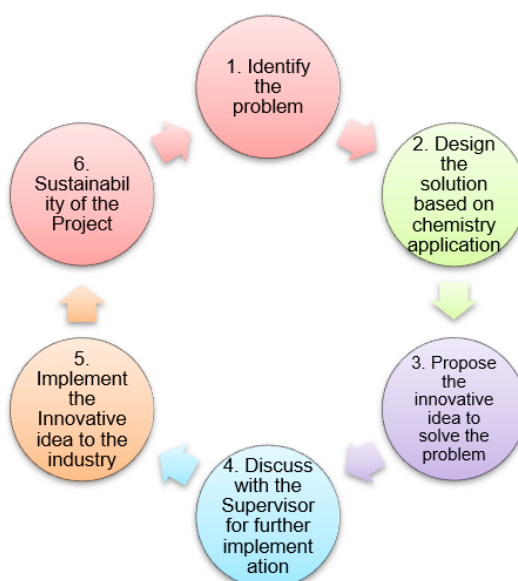


Figure 1. Step for preparing the project-based learning in the society

PROJECT DESCRIPTION

The obstacle faced by the community and society in managing the waste cooking oil is that the chemicals contained may affect the environment causing producing health problems to the society. Society needs to understand how to manage the chemicals so that they do not negatively affect the environment and health.

The source water used by daily workers has poor quality, such as smelly [10], has abnormal pH, high COD (Chemical Oxygen Demand) value [11], and contains heavy metal ions [12]. Problems that trigger these negative impacts can be solved by providing good chemical waste treatment technology. Chemistry students participating in this project-based learning aim to help the community overcome waste cooking oil and provide clean water.

In the previous project-based learning [1], students are asked to search for the literature following the most accessible pyrolysis technology to be applied in the community. Before using advanced technology to solve the community problem, students identified and analyzed the chemical liquid waste from the waste cooking oil to get a preliminary result regarding the quality of the technology. Notably, this effort also supported the student in fostering society's recycling of waste cooking oil.

RESULTS AND DISCUSSION

Analysis of the Society Problem

Students identify the society problem based on their knowledge after completing the five semesters in the chemistry undergraduate program. Students use conventional and modern instrumentation to support their study to analyze the industrial problem. One global issue usually in the industry is liquid waste containing hazardous chemicals from the daily life waste. The student has received the material regarding handling the liquid waste chemical with several techniques in chemistry.

Students can identify the compound of the liquid waste and decide on a suitable solution for society. For the beginning step, students analyze the contain in the liquid waste to know their chemicals. There are 2 reasons why students have to analyze and solve this problem. First, the most common environmental problem is liquid wastewater [13, 14]. Second, the habit of society throwing the liquid waste to the environment can cause several problem in society [15, 16]. Therefore, monitoring the concentration of chemicals the liquid wasted cooking oil and providing the technology to society is crucial.

Students monitor the concentration of chemical by using the Gas Chromatography-Mass Spectroscopy (GC-MS) taught in the laboratory practice in the Department of Chemistry. Students analyze the chemicals from waste cooking oil to determine the initial method to convert it to be renewable energy, i.e. biodiesel and solketal. In this case, it becomes the advantages to the society if they can produce a renewable energy and implement it into daily life [16].

Students need to educate society and industry employees regarding waste cooking oil's profound effect on their health. In addition, they also need to know how to overcome the chemicals present in the waste cooking oil. Students can suggest many chemical technologies to produce biodiesel and solketal from waste cooking oil, such as reflux, distillation, and microwave reaction. Students plan a group discussion with the team, supervisor, and society to implement suitable technology to convert the waste cooking oil to become renewable energy in the environment.

The following communication between the Project Supervisor and Students indicates that students understood the current situation and tried to suggest a possible solution to the wastewater problem in society.

- Project Supervisor:* *How can you describe the current situation of society in waste management?*
- Group of the student:* *They have a problem in waste management, especially in saving environment from liquid chemical waste. Everyday they produce the waste cooking oil from the kitchen and do not know how to manage the liquid waste.*
- Project Supervisor:* *What do you suggest that society solve the liquid waste from the daily life process?*
- Group of the student:* *Based on our knowledge of the Green Chemistry Subject, e.g., prevention of the pollutant and design for degradation, the society must provide chemical waste management for further process of the by-product that contains the hazardous chemicals.*

Choosing Method and Solution

Choosing methods and solutions for solving the problem according to the chemical liquid waste becomes a topic students need to address. The critical thinking skill of the student involves the way to determining the chosen method and solution. We consider this project-based learning only suitable for the 3rd year chemistry department students. They almost took 80% of the subject during their study, whether theoretical or laboratory practice. Notably, their knowledge of chemistry and critical thinking skill influence how they make good decisions. The record of the discussion between the project supervisor and students is presented in the following conversation.

- Project Supervisor:* *You have all learned about handling chemical waste using basic and advanced techniques. How do you suggest the society start their chemical waste management*
- Group of the student:* *We will first analyze and identify the chemical contained in the liquid waste from the by-product. After getting the result from the laboratory, we will discuss with the team and the industry the possible implementation of chemical waste management.*
- Project Supervisor:* *How do you find innovative ideas and implement them in the industry? How do you propose your idea to the industry?*
- Group of the student:* *We will discuss this with the supervisor and ask for their point of view on our idea, determine the method, and design the affordable technology that the laborers in the industry can use for chemical waste management*

Although students can decide the method and solution by themselves, they still need the point of view of the project supervisor. The role of the project supervisor is also vital for the final design of technology. They can analyze and detect all the possible chemicals in the waste cooking oil, but students suggest the possible technology can be implement in society in producing biodiesel and solketal from waste cooking oil.

Transfer Knowledge to the Society

Learning the subject of chemistry via project-based learning must be handled carefully concerning the learning outcome of each course. Each course has a specific learning outcome that the chemistry student should learn, especially in elective classes such as waste recycling technology, catalyst chemistry, green chemistry, etc. One learning outcome is that students can transfer knowledge to society through special project-based learning. Students will learn how to implement their innovative idea in specific project-based learning. The record of the discussion and implementation of the project is presented in the following conversation.

- Project Supervisor:* *How do you teach society about the implementation of your innovative idea?*
- Group of the student:* *We will give the presentation and workshop series about the importance of recycling liquid waste, the use of the technology, and how we operate the technology.*
- Project Supervisor:* *What kind of technology will you use to convert the chemical liquid waste to be useful product? Have you tried it on the laboratory scale?*
- Group of the student:* *We remember from the waste recycling technology lecture that one potential candidate of the technology can be used in the society: the adsorption technology using carbon and natural clay materials.*
- Yes, we have tried it on the laboratory scale, but we need your suggestion to scale it up to the industrial scale.*

Chemistry students learn how to transfer their chemistry knowledge and disseminate it to face real industry problems and give solutions to overcome them. The record of the discussion presented that morals-based learning motivated chemistry students to be effective in helping society find the best solution for their problems. Chemistry students are also motivated to take action to design technology based on the knowledge they got from some courses during their studies. As a result, the project-based learning can be fruitful for society and industry and students gain valuable experience in implementing their innovative idea.

Recognition of Project-Based Learning

Merdeka Belajar-Kampus Merdeka (MB-KM) policy gave lecturers, supervisors, and students many options to implement learning models outside the classroom. Commonly, project-based learning can only be recognized in 1 subject (2-3 credits), and Lecturers and students have limited activities and choices to find the model in their learning process. On the contrary, MB-KM system allowed to conduct one activity of project-based learning to be converted into some course up to 10-20 credits. The example of the project-based learning activities recognized in some elective courses is presented in Table 1.

Table 1. Project Based Learning Activity recognized in some elective courses

No	Subject	Conversion	Status
1	Waste recycling technology	2 credits	Elective
2	Green chemistry	2 credits	Elective
3	Technology of remediation	2 credits	Elective
4	Chemistry product for entrepreneurship	2 credits	Elective

CONCLUSION

This project-based learning gave the good practice in implementing MB-KM policy from the Ministry of Education, Culture, Research, and Technology in Indonesia. Chemistry students can achieve the learning outcome of several courses by only doing one project-based learning. Its program can be recognized not only for 2 credits but also up to 10 credits. In particular, the result presented how the student successfully solves the real-world problem in the community, gives innovative ideas, designs the technology, transfers knowledge to the society, and becomes the real agent of change in society. It is noteworthy that the future project-based learning method's role will be significant for educators and students to choose the best way to solve the real problem in the community.

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