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The Implementation of Education for Sustainable Development-Oriented Problem-Based Learning in Practical Work for Making Alum

Resi Pratiwi[1]*, Hanifah Setiowati[2]
[1,2)] Universitas Islam Negeri Walisongo Semarang, Indonesia
* E-mail Corresponding Author: pratiwiresi@walisongo.ac.id

Abstract

The problem-based learning (PBL) method is one method to insert the competency targets of Education for Sustainable Development (ESD). This research aims to investigate how the implementation of ESD-oriented problem-based learning to metal and non-metal chemistry practical work. The research method used in this research is a qualitative descriptive method and the research subject is the 4th-semester Chemistry Education university students. The research result shows that the ESD-oriented PBL method is applicable in metal and non-metal chemistry practical work. Practical work with the ESD-oriented PBL method can be used as an innovation for practical learning activities to achieve the ESD target competencies. Based on the questionnaires responded by the students, it can be concluded that the practical work with the ESD-oriented PBL method could increase the students' ability for problem-solving with percentages of 33% strongly agree and 50% agree. Practical work learning with the ESD-oriented PBL affects the students to be more active in practical work activities. The stages of the PBL method help the students develop problem-solving abilities, and this is one target of ESD competencies.

Keyword: problem based learning; education for sustainable development; practical work

Abstrak

Metode *Problem Based Learning* (PBL) merupakan salah satu metode untuk memasukkan target kompetensi *Education for Sustainable Development* (ESD). Penelitian ini bertujuan untuk mengetahui implementasi pembelajaran berbasis masalah berorientasi ESD pada praktikum kimia logam dan non logam. Metode penelitian yang digunakan dalam penelitian ini adalah metode deskriptif kualitatif dan subjek penelitian adalah mahasiswa Pendidikan Kimia semester 4. Hasil penelitian menunjukkan bahwa metode PBL berorientasi ESD dapat diterapkan dalam praktikum kimia logam dan non logam. Kerja praktek dengan metode PBL berorientasi ESD dapat dijadikan sebagai inovasi kegiatan pembelajaran praktek untuk mencapai kompetensi target ESD. Berdasarkan angket yang ditanggapi oleh siswa dapat disimpulkan bahwa praktikum dengan metode PBL berorientasi ESD dapat meningkatkan kemampuan pemecahan masalah siswa dengan persentase 33% sangat setuju dan 50% setuju. Pembelajaran kerja praktek dengan PBL berorientasi ESD mempengaruhi siswa untuk lebih aktif dalam kegiatan kerja praktek. Tahapan metode PBL membantu siswa mengembangkan kemampuan pemecahan masalah, dan ini merupakan salah satu target kompetensi ESD.

Kata kunci: problem based learning; education for sustainable development; kerja praktek

Introduction

The achievement of educational goals is an important social aspect of national development aspects. Education for Sustainable Development (ESD) is an idea presented from the environment and the human crisis issues which are faced in the present time and in the future. The term ESD in Indonesia is known as *Pendidikan Pembangunan Berkelanjutan*. This program is organized by the United Nations (UN) directly under UNESCO (United Nations Education Scientific and Cultural Organization). One of the targets of implementing ESD is to educate and prepare the young generation to face the challenges in the world of challenges as a form of responsibility towards the future (UNESCO, 2020). Education for Sustainable Development (ESD) is a lifelong learning process with the aim of informing and engaging society to be creative, to have problem-solving ability, to have both social and scientific literacy, and also commit to be bounded to the personal and group responsibility. Such action will ensure an economically prosperous environment in the future.

Several competencies which become the targets of ESD are; critical thinking and integrated problem-solving competence. These competencies can be improved through learning activities in the school. ESD is developed and carried out with different approaches, based on the countries that developed it. There are several countries that develop ESD through cross-curriculum, hidden curriculum, and intro-curriculum so that it appeared as a stand-alone subject (Segara, 2015). The result of a research by (Listiawati, 2013) in various schools in Indonesia it is discovered that the ESD values in schools are applied in several ways; 1) integrated into the subjects; 2) through local subjects being its own subject, 3) through extra-curricular activities or self-development programs, 4) adjustment (refinement) which is the application of the school's mission and vision and also the school regulations. The implementation of ESD through integration and adjustment in schools is done through several variation (Aisy & Gunansyah, 2020; Listiawati, 2013). This shows that the ESD target in school could be included in the learning process through learning methods. The result of a research by (Laurie et al., 2016) also proves that pedagogical ESD facilitates learning knowledge, and promotes skill learning, perspective and values needed to build and maintain a sustainable society.

Problem-based learning (PBL) method is one method used to insert targets of ESD competency. The PBL method could be considered as one process that challenged the students to work in groups to solve the world's problems and demanded to solve the problems (Kristiana & Radia, 2021).

According to (Al-Fikry et al., 2018; Alimirzaloo & Hashemnezhad, 2016; Nuryanto et al., 2015; Syaribuddin et al., 2016), the activity in problem-solving and making decision demanded the students to have high level thinking which thinks critically. Adeyemi (2012) stated that think critically stimulate someone to analyze and evaluate his/her thought and reduce the risk in taking the wrong decision in solving an every day problem. The PBL implementation in learning process at school also proves that it could improve the students' achievement, trains the communication skills, and together; improve the creative thinking and problem-solving competency and also increase the students' learning motivation (Abdurrozak et al., 2016; Priyani et al., 2019).

The PBL method is applicable in various types of learning and practical work is one of them. Practical work is one of learning activities that aims to provide an in-depth understanding and an applicable mastery of the material. The practical work activities could develop the psychomotor domain. For pre-service teacher, the practical work activities is very important to do. The purpose is for the students who are pre-service teachers to have in-depth knowledge on the materials to be taught.

The metal and non-metal chemistry practical work is one of the subjects of practical work given to university students of Chemistry Education. The practical work

activities are often done by using the ingredients in the laboratories. This research is aim to discover how ESD-integrated PBL method is implemented to metal and non-metal chemistry practical work learning.

Method

This research is a case study. The subject of this research is the 4th semester chemistry education university students who took the subject of metal and non-metal chemistry practical work, which is 18 students in numbered. The theme of the practical work is the object of this research that is the synthesis of the materials with non-aqueous media. The research instrument used is a questionnaire that is adopted from the research by (Pratiwi et al., 2019).

Result and Discussion

The practical work done is a course of metal and non-metal chemistry. The practical work is done by using used cans as the main item of making alum. This was done so that the students are able to utilize used goods that have the potential for the synthesis of certain compound. The utilization of used cans is also directing the students to reduce waste cans. So that the practical work done could achieve the ESD competency. The students are asked to solve the environmental problems on waste goods, the used cans utilized in this practical work is drink cans. These cans are made of aluminum. The practical work activities done are employing the PBL method, where students are asked to solve problems. The PBL method consisted of 5 stages, they are; problem orientation, students' organization, guide the investigation, developing and presenting the investigation result, and analyzing and evaluating the problem-solving process (Arends, 2008).

The PBL syntax in the practical work done in this research can be seen in the Table 1 below.

The first stage in practical work activity is problem orientation. The students are given problems on the abundance of used cans which have not been utilized in chemistry. This aims for the students to search information on materials which are used to make used cans and its characteristics. This stage is also used to stimulate the students' critical thinking.

The next stage is organizing the students. This stage is design to give directions and instructions related to the assignments the students must do to solve the given problem (Langitasari et al., 2021). Students are asked to find literature reviews on utilizing used cans to make alum. The purpose of these activities is that the students should collect information on how to make alum for various sources.

The stage of guiding the investigation, students do the practical work activities in making alum. The materials used in making alum in used cans. The practical work activities are done by paying attention to practical work instructions and example video from the social media on the practical work. These are done for the students to compare the results which are achieved from other sources. There are several groups that faced difficulties during the practical work activities.

The result of their alum is not in accordance with the literature. These are caused by several reasons, one of them is the dissolving of the used cans. An example of the practical work activities done by the students are shown in Figure 1.

The fourth stage is developing and presenting the result. In this stage, students discussed with their groups to calculate the yield of the finished alum which is then written in a report. Students also compare the finished alum made from used cans with the alum made from aluminum that is found in the laboratory. The students then present the result of the practical work activities that have been done. According to (Abanikannda, 2016) the activity of discussion, according to PBL, could stimulate the students' interpersonal skill, they are; listening skill, negotiation skill, compromising skill,

education skill, giving and accepting critics, and skills to motivate others.

Table 1.
The PBL Syntax in the Practical Work

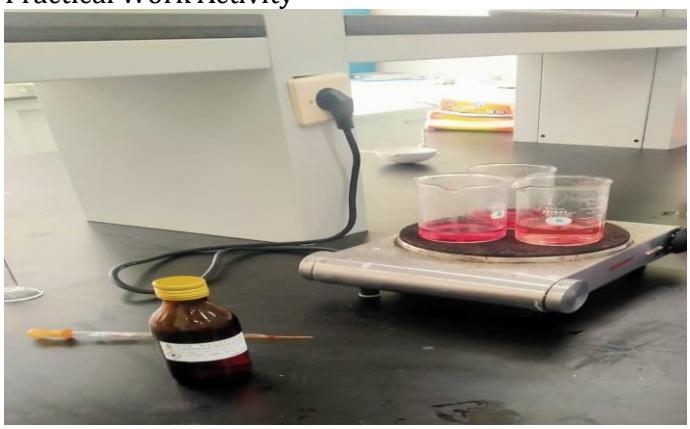
Phase	Indicators	Lecturer Activity	Student Activity
1	Problem orientation	• Explaining the purpose of the practical work which is the synthesis of the materials with non-aqueous media • Stating out the problems of utilizing used cans	• Listening to the instruction from the lecturer and asking questions if there is anything not understood
2	Students' organization	• Organizing the students to find literature reviews on utilizing used cans and turning into alum	• Searching for literature reviews on the process of making alum out of use cans • Taking notes on the reactions that happen during the process of making alum out of used cans
3	Guiding the investigation	• Guiding and supervising the students in practical work in making alum out of used cans • Giving instruction if the students constrained on equipment and materials	• Doing practical work in making alum out of used cans • Observing every process that are done during the practical work
4	Developing and presenting investigation result	• Helping the students to arrange and provide the result of the practical work that is in a form of temporary calculation and report which will be presented	• Making calculation of the alum yield, writing temporary report and present the report
5	Analyzing and evaluating problem-solving process	• Helping the students to understand the concept of making alum using used cans • Explaining to the group which has not succeed in making alum (practical work failed)	• Reflecting and evaluating to the practical work that have been done • Writing the correct equation for the reaction of making alum and identifying the procedural error in the practical work

The last stage is analyzing and evaluating the practical work activities which have been done. During this stage, students reflect on what caused the failure during the practical work. The lecturer explains the correct practical work procedures and points out the procedural errors that have been done. According to the practical work experience, students could apply the ESD concepts in other subjects' practical work activities.

These stages of PBL give the students learning experiences and could form the frame of thinking so that the learning indicators can be achieved well (Desriyanti & Lazulva, 2016). Through the PBL model, during the group discussion, each member has the responsibility for the learning success. Each member is hoped to be active and participate taking part in the activities that should be done. This is done to create good cooperation as the form of responsibility from each member of the group. These activities could stimulate the students' critical thinking to be more critical (Pusparini et al., 2018). Another reason is that the implementation of PBL in learning could improve; the students' learning achievement, the students' understanding, the communication skills, the problem-solving competence, and develop positive

attitude towards chemistry (Abanikannda, 2016).

Figure 1.
Practical Work Activity



According to the observation result, during the practical work activities by ESD-integrated PBL, several students are still making mistakes in writing the reaction that happened while making alum.

The practical work activity by PBL method engage the students to achieve the ESD targets. The activities involved; discussion, analysis, and employing values. The lecturer could relate the practical work theme of the academic script with the issues of sustainable development. The practical work activities implementing the ESD targets are hope to comprehend and achieve the target of sustainable development especially in the education field.

After the practical work activities are done, the students are asked to fill in responses related to the learning process. The result of the students' responses are shown in Table 2 below.

Table 2.
The Students' Responses of the PBL Implementation in the Practical Work of Makin Alum

No.	Aspects	The Number of Students (%)			
		SS	S	TS	STS
1	The course of metal and non-metal practical work is hard	28	56	17	0
2	The practical work activities done are hard to be understood	28	56	17	0
3	Students did the practical work according to the instructions	56	44	0	0
4	Happy to study with the PBL method	33	56	11	0
5	Has ever followed ESD-integrated PBL method	0	28	72	0
6	PBL method improve the ability to give solution in problem-solving	33	50	17	0
7	ESD-integrated PBL practical work increased the knowledge on the environmental issues	56	44	0	0
8	ESD-integrated PBL increased the knowledge in utilizing waste for practical work activities	56	44	0	0

According to Table 2, it can be concluded that ESD-integrated PBL practical work activity increased the students' problem-solving ability. Such method of learning also effected the students to be more active during practical work activity. Students did not only focus on the practical work instruction book but also searched other references used for comparing their practical work's results. The competency that both the graduates and the students possessed are hoped to be the provisions to achieve the sustainable society (Ghany, 2018). This research is limited to only the implementation of PBL method for practical work in making alum and have not yet investigated the effectiveness of PBL method implementation to the learning achievements.

Conclusion

The education for sustainable development integrated with problem-based learning method can be applied for metal and non-metal chemistry practical work activities. Practical work with ESD-integrated PBL method could be used as innovations in practical work learning to achieve the ESD competency targets.

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