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PROBLEM BASED LEARNING ON ENVIRONMENTAL CHEMISTRY WITH ARTICLE PRODUCTS TO IMPROVE STUDENT KNOWLEDGE

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Abstract

Style of the teaching chemistry course is teacher centred approach and cause the less student performance assessment that will effects the student creativity development. The aims of this research is to apply the problem based learning on the environmental chemistry course with structured task to improve the students' knowledge. This research was conducted experimental study by using the pre-and post-test control group design. The sample of this research is the chemistry education student who took a course in the environmental chemistry which started the student batch from year 2015-2016. Class A is chose as the treatment group whiles the class B as the control group. Data were obtained from observation and pre- and post-tests. Descriptive statistics used in this study include mean value and N-gain. The test result shows the mean value score test of the post-test treatment group is 83.07 which is higher than the control group obtained 77.80. N-gain results showed that there were significant of result test student knowledge after the treatment where the treatment group is increase by 0.73 (high criteria) as compared to control group achieved 0.67 (middle criteria). Based on these results, it can be concluded that the Problem Based Learning approach improve the tool teaching and increase the student understanding on the environmental chemistry course.

Keywords: Environmental chemistry, Student' knowledge, Problem-based learning, Chemistry education.

1. Introduction

Human resources depend on the quality education and the current market demand. The role of education is very important to create a quality human being. Preparation

of the qualified human resources is essential for a country's needs. Therefore, Problem-based Learning (PBL) is introduced as a new methodology teaching to enhance the understanding of proses learning instead of memorising the facts [1, 2]. Teaching 'difficult subject' is quite challenging due to the nature of the subject and most teachers who teach this subject use the traditional teaching method [1]. "Difficult subject" of process learning required more exercise in term memorising fact instead of understanding the subject matter and majority teacher still preferred this method due to the exam-oriented system [1, 3]. PBL development the critical thinking skills, enhance the problem-solving abilities and help the communication skills.

In order to improve the learning outcomes of the environmental chemistry course is by using the PBL. PBL is one of the learning methods that prioritises the suitability of learning with daily lives and using the meaningful real-life problems as its foundation. Thus, PBL application can produce many abilities of the students [4, 5]. In PBL, learning activities take place in a collaborative group of heterogeneous, so each of individual confirms the idea to solve the problem of environmental chemistry. Students become more encouraged in their learning activities. PBL give students the opportunity to work more independently.

Environmental chemistry is the scientific study of the chemical and biochemical phenomena which occur in nature. Environmental chemistry related to sources, reactions, transport, fate, and effects of chemicals in the environment of air, soil, water, and public health. Critical thinking skills cannot be separated with the ability to think creatively. The ability to think creatively is very suitable to be developed with problem-based learning model [6].

The approach of writing and analysing the subject matter create the awareness of the students to understand the gap analysis in the environmental chemistry course [7]. Producing article can improved the knowledge and help to understand the subject matter of the students. A topic covered in the environmental chemistry course is closely associated in our daily life. This study was conducted to identify the students' understanding about environmental chemistry course by using the PBL model.

2. Method

This research was conducted at Chemistry Education Program of Universitas Negeri Semarang (UNNES) through the environmental chemistry course. The research design used is pretest-posttest control group design. There are three (3) classes in the chemistry education study program. Two (2) classes were chosen in this study by using the random sampling technique [8]. Class A is assigned as experimental group and will be treated with PBL model and producing article while class B is chosen as control group is treated with PBL model without producing article. Learning steps of treatment group is shown in Fig. 1.

Students have to search four (4) resources from different references related to the topic of environmental chemistry from different sources such as book, journal, proceeding and magazine. Book will be the best reference for the fundamental theory but technical paper usually highlight the recent study in term

of methodology, theory and findings. The first step, the student required to do the systematic review.

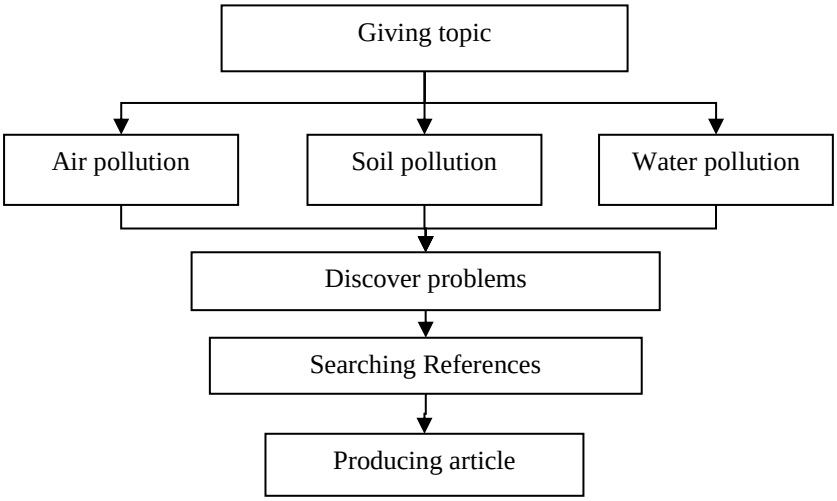

Fig. 1. Learning steps of treatment group.

Students discuss three topics of the air pollution, soil pollution and water pollution by using PBL model. The article will be producing only in the treatment group by individually however they can work as group in searching the articles. Lecturer set the rules of the minimal amount reference used to produce the article from two different resources which cited from the international journal and local journal. The topics that they can choose is air, soil or water which related to environmental chemistry course. Then, they have to analyse the chemistry compounds contained therein, discuss the issues and problems that exist in daily life.

The independent variable in this research is the learning method where the treatment group use the PBL with producing an article while the control group used PBL without producing an article. The dependent variable is knowledge and the control variable is the curriculum, the lecturer, the material, and the duration is 14 weeks and per session will take 100 minutes. Data collection is done by written test method of learning result of knowledge aspect. Data obtained in this study were analysed by using the descriptive analysis. In this research the lecturer acts as a facilitator who provides direction and facilitates the students to produce an article.

3. Results and Discussion

The written test scoring data for each topic of air, soil and water where obtained from this study are presented in Tables 1 and 2. The pre-test and post-test values are also reviewed based on the PBL model.

Table 1. Student knowledge pre-test value of experimental group and control group reviewed.

Aspect	Experimental group						Control group					
	1	2	3	4	5	$\bar{x}$	1	2	3	4	5	$\bar{y}$
Air pollution	34	34	39	34	38	35.8	35	32	37	35	36	35
Soil pollution	34	30	36	33	34	33.4	34	33	31	30	32	32
Water pollution	36	34	36	31	35	34.4	34	34	32	33	32	33
Mean	34.6	32.6	37	32.6	35.6	34.53	34.3	33	33.3	32.6	33.3	33.3

Table 2. Student knowledge post-test values of experimental group and control group reviewed.

Aspect	Experimental group						Control group					
	1	2	3	4	5	$\bar{x}$	1	2	3	4	5	$\bar{y}$
Air pollution	90	72	90	91	92	87	83	70	83	82	80	79.6
Soil pollution	80	70	75	77	77	75.8	74	67	73	75	73	72.4
Water pollution	90	74	88	89	91	86.4	85	70	84	84	84	81.4
Mean	86.7	72	84.3	85.7	86.7	83,1	80.6	69	80.3	80.3	79	77.8

Information:
1. Selection of pollutants (chemicals) as outlined in the title
2. Sources of data, reliable source.
3. Data processing techniques
4. Data analysis and conclusion
5. Physical form and product innovation (article).

The enhancement of test result the student knowledge analysed by using gain index formula [9]:

$$\boldsymbol{N\ gain\ (g)} = \frac{< posttest > - < pretest >}{< maximum\ score > - < pretest >}$$

Information:

<Posttest> = Percentage of post-test value
<Pretest> = Percentage of pre-test value

Criteria revenue gain index is illustrated in Table 3 [2].

Table 3. Criteria of N-gain (g) index.

Value Range	Information
$g > 0.70$	High
$0.30 \leq g \leq 0.70$	Medium
$g < 0.30$	Low

The Normalise gain calculation of the mean pre-test and post-test values of environmental chemistry course can be seen in Table 4.

Table 4. Mean pre-test and post-test for each material aspect.

Aspect	Experimental group			Control group		
	Pre-test	Post-test	g	Pre-test	Post-test	g
Air pollution	35.80	87.00	0.79	35.00	79.60	0.69
Soil pollution	33.40	75.80	0.63	32.00	72.40	0.59
Water pollution	34.40	86.40	0.78	33.00	81.40	0.72
Mean	34.53	83.10	0.73	33.30	77.80	0.67

Knowledge assessment were run twice, there are pre-test and post-test. The results of learning knowledge (post-test) in general can be seen in Tables 2 and 4, the value score of the environmental chemistry experimental group is 83.10, whereas in the control group is 77.80. While, mean pre-test for the experimental group is higher (34.53) as compared to control group is 33.30. Experimental group value for N-gain is 0.73 which is categories as high and control group obtained 0.67 where fall under category medium according to Table 3. Problem-based learning model can improve the results of the study to the aspect of knowledge. Students were invited to work on projects that lead to solving the problem. Increased knowledge of students of treatment group and control group as presented in Fig. 2.

PBL is the learning designed tool in order to help the student to develop their thinking skills and enhanced the skill in ceasing the problem through the real situation [10,11]. The PBL lesson activities take place with collaborative approach in the form of heterogeneous group, where they can discuss much better. Students become more motivated in their learning with facing the real problem. In other circumstances, the discussion is not effective if the group members are unskilful, immature and lack knowledge [12].

The division of tasks should be taken into account the title of the article, each of which has a variety of themes and presenting the results in the class. N-gain for air pollution article writing test from experimental group is 0.79 (high) as compared to control group is 0.69 (medium). Soil pollution article writing test for N-gain experimental group is 0.63 (medium) while the control group is 0.59 (medium). Water pollution article writing test obtained N-gain experimental group is 0.78 (high) while 0.72 (high) result for the control group. Students in the control group have moderate thinking skills and even high ability in solving problems. The conclusions can be drawn, in terms of analysing and summarising better data of the experimental group, because they read more articles and have the ability to analyse the problems and come out better solutions.

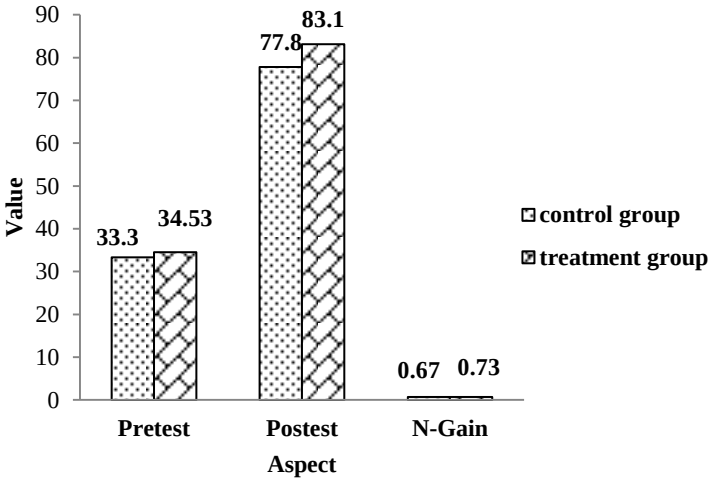

Fig. 2. Enhancement of the student knowledge.

The effort in reading articles and analysing the gap research able to contemplate and thought up to be practiced and developed new idea is a quality way of reading because not only happens the process of absorption information but there is a process of selection, processing, and creative effort in upcoming issues to be developed [13]. PBL also encourages students to be able to develop their own knowledge. Thus, it can be concluded that PBL can improve student knowledge in environmental chemistry course.

Students in the experimental group proved to gain higher knowledge on the environmental chemistry course so that in carrying out the implementation activities of PBL steps are also better. Students who are interested in learning will be manifested through participation in activities [14]. Thus, students who have high interest can perform better activities so that the results can be improved. Aappropriate characteristics and strategies in learning play an important role in achievement in learning and project creation [15]. The test questions of the environmental chemistry course where designed according to the PBL five (5) stages such as selection of pollutants, source of data, data processing techniques, data analysis and conclusion, and physical form and product innovation as presented in the Table 5.

Table 5. Mean values of knowledge in accordance with the PBL stages.

Aspect	Experimental group		Control group	
	Mean score	Criteria	Mean score	Criteria
Selection of pollutants (chemicals) that are considered important and poured in the title	86.7	Very high	80.6	High
Source of data, reliable source quantity	72.0	High	69.0	Medium
Data processing techniques	84.3	Very high	80.3	High
Data analysis and conclusion	85.7	Very high	80.3	High
Physical form and product innovation	86.7	Very high	79.0	High
Amount	81.3		77.8	

This research has good results on this environmental group because students make article products during learning activities. Learning using environmental chemistry articles from the internet affects student learning outcomes [16]. The students' knowledge of environmental chemistry is not only a concept but also its application in everyday life. Social-science topics are well suited for learning, where students are directed to master science literacy and sustainable competence [17, 18]. Based on the Table 5, the source of data and reliable source quantity shows the lowest mean score as compared to the other aspect of knowledge but still in the classification of high criteria. The students is still in the stage of searching quality and reliable information from various sources such as book, journal, proceeding and report.

4. Conclusion

Based on the results of the analysis and discussion it can be concluded that learning via PBL and writing article able to improve the student knowledge in the environmental chemistry course as well as improve creative thinking skill and creative actions of students. The obstacles of this research is the limitation in how to search quality journal, book, proceedings and report where can be improved for the next batch students. It is also suggested that in future, the task problem for PBL model required to be focused title. In order to measure the real performance of the individual required presentation, observation and portfolio to assess the understanding based on the writing article and develop the creative thinking skills and creative actions.

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