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The Usage of Recycle Materials for Science Practicum: Is There Any Effect on Science Process Skills?

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ABSTRACT

This study aimed at determining the effect of recycle materials usage for science practicum on students' basic science process skills of the Open University, Surakarta. Recycle materials are the term used for the obtained materials and equipment from the students' environment by taking back the garbage or secondhand objects into goods or new products which have a benefit for practicum activities. Randomized posttest only control group design was applied in this study and involving 83 students which divided into experimental class and control class. Collected data were science process skills test and questionnaire. The results of this study obtained Kruskal Wallis test result of 0.000<0.05. So, there was effect of recycle materials usage for science practicum on students' science process skills. Students also provided positive feedback on the use of recycle materials for science lab activities.

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1. INTRODUCTION

Science and technology rapid development in the 21st century requires an adjustment in various fields, including education. Griffin et al (2015) stated that the need for changes to the education system in 21century because it is not in accordance with the today era [1]. Education, especially in learning requires the use of constructivist approach. Teachers are not the learning center any longer but the students are. Scientific concepts are no longer transferred by the teacher to the students but the students are guided to construct their own knowledge. According to Ananiadou, K. & Claro, M. (2009) some of the keys success factors for 21st century learning policy are the training of qualified teachers, relevant and integration curriculum, clear and precise assessment [2]. Based on The Partnership for 21st century learning (2015) there are three frameworks skills that need to be mastered to the students [3]. These framework include life skills and career (life and career skills), skills, innovation and learning (learning and innovation skills), and media skills, information, and technology (information, media, and technology skills). Based on these descriptions can be seen that to be successful in the 21st century learning needs to pay attention to constructivism in learning, creation of appropriate policies, and mastery of certain skills in learning.

Science learning in 21st century must be in accordance with the nature of science itself. Carin (1997) stated that in learning science students are not only required to master the science concepts (products), but also pay attention to the process and attitude [4]. Science products may include science knowledge, including law, postulate, theories which students learned. The process of science includes scientific procedures in locating the products of science. The scientific procedures were done when students build the knowledge that requires a set of skills. The skill is science process skills. Attitudes constructed while and after a scientific proceeding is scientific attitude. To facilitate the students in these three aspects, the science practicum learning model has a very important position in science learning.

Science practical has a very important role in learning science. Subiantoro (2010) stated that through practicum, students have opportunities to develop and apply the science process skills, scientific attitudes in order to acquire knowledge [5]. According to Hofstein&Lunetta (2003) laboratory (lab) activity is the foundation on the 21st century science education [6]. Thus one of the practical roles of 21st century science learning is to facilitate students to develop science process skills. The importance of science practicum in science learning lead science student teachers must be trained to manage lab science class (Hazzan&Lappidoth, 2004; Fazio &Folante, 2011) [7]-[8]. Thus not only the science teachers and students but also students of science teacher candidates must also understand the importance of practicum in science learning.

Science process skills are a set of skills used by scientists to conduct scientific investigations. This is a skill that must be mastered by the student (National Science Teacher Association, 2003) [9]. There are two types of science process skills which basic science process skills and integrated science process skills (Padilla, 1990; Roth &Roychoudhury, 1993) [10]-[11]. Science basic process skills are examining the basic process, drawing conclusions (inferring), measuring, communicating, and predicting. While the integrated science processes skills are variables, operational definition, hypothesis formulation, experimentation, and models formulation. The selected science process skills in this study are observing, communicating, experiments planning, predicting, and asking questions (Livermoore, 1967) [12]. Students in primary and secondary schools at least be able to master the basic science process skills, while college students were able to master the integrated science process skills.

Science process skills measurement can be done by testing and non-testing. Measurement of the non-test is done by making the observation science process skills sheet. The advantage of this measurement is enabling to directly see the students' process skills. However, the weakness is the use of large sample. The advantage of science process skills measurement by test is the efficacy measurements if using a large sample (Gerald &Okey, 1980; Shahali&Halim, 2010) [13]-[14]. While the weakness is, it cannot directly observe the students' science process skills. The other measurements can be done by using science process skills inventory sheets (Arnold &Bourdeau, 2009) [15].

Science learning should ideally be done through practical methods in the laboratory using standardized equipment and materials lab. As the matter of fact, science practicum is rarely implemented by specific reasons such as lack of infrastructure facilities and laboratory space. The high cost to build a laboratory building/space and to acquire the equipment and laboratory equipment. It causes most the schools in Indonesia do not have laboratory facilities. Ministry of Education and Culture mentioned that only 45% of secondary schools in Indonesia have science laboratory facilities. Those were the obstacles in implementing practical activities that require laboratory equipment.

Besides the facilities and infrastructure factors, the teachers' quality is also caused the science lab activities are not optimal. There are still many educators who do not perform lab activities due to certain constraints. According to Anggraeni (2001), many teachers are reluctant to carry out practical activities for it consumes a lot of time and energy [16]. Meanwhile, according to Gabel (1993), the obstacles of lab activities implementation are the lack of equipment and materials lab and the lack of the teachers' skills in managing lab activities [17].The absence of science learning practical implementation does not impact on the development of the students' science process skills. Science practicum learning in Open University is a compulsory subject using distance learning system. According to the Rector UT decreeNo. 3466/H31/ KEP/2008 mentioned that this course contains topics such as practical living things, the relationship of living things and the environment, food, mechanics, heat, waves, optics, electricity, magnetism, and the earth and the universe. Rumanta (2008) states that by following the science lab activities in elementary school, students can clarify concepts that have been studied, develop experimented skills, thinking skills, and scientific work [18]. The facing obstacle is the lack of laboratory space to support remote practical activities. Some classes get a kit lab class while others are not. It made the implementation of practical activities do not run properly. Thus, it needs to find a solution to overcome the obstacles.

One of the solutions to the problem is using recycle materials as the science practicum facilities. Recycle is a process of taking back the garbage or secondhand objects into goods or new products which have a benefit (Prose, 2008) [19]. Recycle materials can be materials/equipment that are still used for everyday purposes or derived from inorganic waste. The use of recycle materials derived from recycled waste can be one of the solutions to overcome the problems of serious concern inorganic waste today. Reuse of plastic bottles can also be used as a recycle material for simple microscope (Tunggal, 2011) [20]. Not only that, glass bottles supplement drink and straws can also be used to replace the respirometer tube and pipe at respiration experiment. Not many science teachers aware of recycled materials usage for practicum in school. The use of recycle materials is environmentally friendly and also can save capital expenses from the education institution. For example, a comparison between lab equipment using recycle materials with factory-made lab equipment are presented in Figure 1.

Figure 1. (A) Simple recycle materials respirometer (source: writers' documentation), (B) Manufactured respirometer (source: tokoedukasi.com)

Based on Figure 1, a simple respirometer can be made by using recycle materials such as used bottles glass, clear straws, rulers, and plasticine. While factory respirometer made of glass with a buffer. Both Respirometer A and B can be use properly.Based on the background, practicum activities should be able to facilitate students' science process skills. But the practicum activities were not conducted due to various constraints. One of the obstacles is the unavailability of equipment and laboratory materials. Recycle materials have the potential to be developed into equipment and materials for practical activities. Thus it is necessary to study the effect of recycle materials usage for science practicum on science process skills.

2. RESEARCH METHOD

Randomized posttest only control group design was applied in this study which involved 83 students, and they were divided into experimental class and control class. The criteria of experimental class is open university students 2nd semester performed practicum using recycle materials while the criteria of control class was open university students 2nd semester performed practicum using science practicum kit that has been provided by university. The Practicum kit was provided by university include fabric respirometer, beaker glasses, tube tests, pipettes, reagent tester, measuring tubes, optical kit, etc. Posttest was performed at the end of the lesson for each class (Ary et al, 2013; Sudijono, 2001) [21]-[22]. Research design was clearly presented in

R	X	O_1
R		O_2

Description: R: Random Class; X: Treatment; O: Posttest

The data collection was done by the science process skills test and questionnaire. Basic science process skills test consists of 10 items essay questions that have been developed previously. Prajoko, et al. (2016) suggests this test has meets the construct validity and content validity [23]. The reliability of the science process skills test result presented in Table 1.

Table 1.Reliability of Science Process Skill Test Result

Reliability Statistics	
Cronbach's Alpha	N of Items
0.876	10

Based on Table 1, it can be seen that the Cronbach's Alpha score of the test is 0.876. It means that this test meets the criteria of reliability, so it can be used from time to time consistently. Students' feedback questionnaire contains 10 questions about the recycle materials based science practicum with direct feedback on its usage for science practicum. Prajoko, et al. (2016) state that the students' feedback questionnaire meets the criteria construct and content validity [23].

2.1. Data Analysis

Data analysis in this study included prerequisite test analysis and hypothesis testing of science process skills data results. Analysis prerequisite test included normality test, homogeneity test, and linearity test. Normality test aimed at determining the normality of the distribution of research data. Data normality was tested using the Shapiro-Wilk test. The aimed of homogeneity test was to determine the variance of a population whether it was the same or not. Homogeneity was tested using Levene Statistic. Linearity test aimed at determining if the data has a linear regression or not. Data analysis was assisted using Microsoft Excel 2010 and SPSS 18. Questionnaire responses regarding students' learning using recycle materials were descriptively analyzed.

3. RESULT

Summary of science process skills test results of the experimental class and control class presented in Table 2. Based on Table 2, it can be seen that the average value of science process skills of the experimental class is higher than the control class. Distribution science process skills test scores of the experimental class and the control class were presented in Figure 2.

Table 2. The Summary of Science Process Skills Test of the Experimental Class and the Control Class Results

Score	Experiment Class	Control Class
Maximum	90	79
Minimum	54	55
Average	78	70

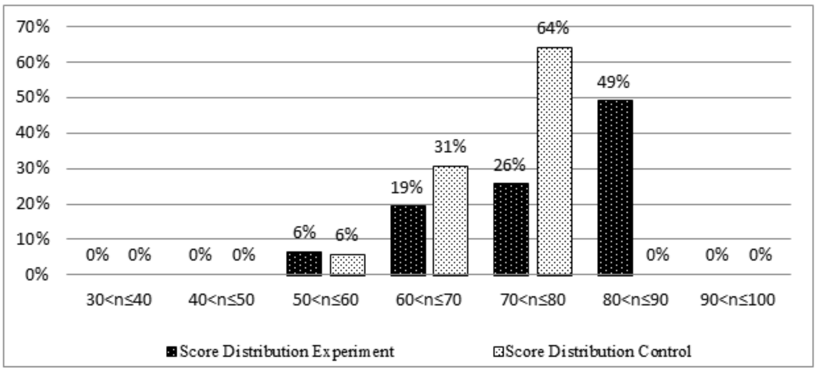

Figure 2. Histogram distribution of science process skills test scores of the experimental classes and control classes

Figure 2 showed that the distribution of science process skills test value for the experimental class and control class was variety. Distribution science process skills test scores of the experimental class majority (49%) in the value range of $80 < n \leq 90$, while the control class majority in the value range $70 < n \leq 80$ (64%).

3.1. Test Requirements Analysis

Prerequisite test analysis was used to determine the obtained data of this study met the elements of normality, homogeneity, and linearity. This was useful for parametric or non-parametric statistical test for hypothesis testing. Analysis prerequisite test included normality test, homogeneity, and linearity test using SPSS18 with a significance level (α) of 0.05. Normality test aimed at determining the normality of the data distribution of this study. Normality test results were presented in Table 3.

Based on Table 3 it can be seen that the significance derived from the Shapiro-Wilk test was 0.00 <0.05. Thus the value of data science process skills distribution was not normal. Homogeneity test was used to determine if the variance of a population was the same or not. Homogeneity test results were presented in Table 4.

Table 3. Normality Test Results

	Treatment	Shapiro-Wilk		
		Statistic	df	Sig.
Science Process Skills	Experiment	.890	47	.000
	Control	.842	36	.000

Table 4. Homogeneity Test Results

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Science Process Skills	Based on Mean	.230	1	81	.633
	Based on Median	.433	1	81	.512
	Based on Median and with adjusted df	.433	1	75.350	.512
	Based on trimmed mean	.314	1	81	.577

Table 4 showed that the significance obtained from Statistics Levene test based on a mean was 0.633> 0.05. Thus the sampling population derived from variants of this study was homogeneous. Linearity test aimed to determine whether the data has liner regression or not. Linearity test were presented in Table 5.

Table 5. Linearity Test Results

ANOVA Table [a,b,c]							
			Sum of Squares	df	Mean Square	F	Sig.
Science Process Skills * Treatment	Between Groups	(Combined)	28348.181	1	28348.181	341.092	.000
	Within Groups		6731.915	81	83.110		
	Total		35080.096	82			

Based on Table 5 it can be seen that the significance derived from Anova test was 0.000 <0.05. Thus the data did not have a linear regression. Conclusion of analysis prerequisite test analysis results presented in Table 6.

Table 6. Summary of Test Analysis Prerequisites Results

Prerequisites Test Analysis	Test Results: fulfilled	Test Results: not fulfilled
Normality	-	v
Homogeniy	v	
Linearity	-	v

As shown in Table 6, test of homogeneity met the requirements analysis. Thus the statistical hypothesis testing was done by non-parametric. Siegel, S (1997) stated that if the test did not met the requirements analysis, non-parametric statistical analysis can be used as an alternative statistic test [24]. De-Long et al (1988) also stated that non-parametric statistical analysis performed if the data is abnormal [25].

3.2. Hypothesis Testing

Kruskal Wallis test using SPSS 18 as employed in this study. Results Kruskal Wallis nonparametric statistics presented in Table 7. Based on Table 7, Kruskal Wallis obtained significance of 0.000 <0.05. The results showed that the working hypothesis was accepted, while the null hypothesis was rejected. Thus there was a significant influence on the practical use of recycle science materials against science process skills.

Table 7. Results of the Research data Hypothesis Testing

	Science Process Skill
Number of Levels in treatment	2
N	83
Observed J-T Statistic	1.000
Mean J-T Statistic	846.000
Std. Deviation of J-T Statistic	108.595
Std. J-T Statistic	-7.781
Asymp. Sig. (2-tailed)	.000

4. DISCUSSION

Based on the results of Kruskal Wallis test, practicum science problems based learning using recycle materials on science process skills got significance of 0.000 <0.05. The result indicated a significant effect on the improvement of science practicum on science process skills learning using recycle materials. The average value of science process skills between the experimental class and the control class was not significantly different. The average score of the experimental class was 78, while the average score of the control class was 70.

Practicum learning using recycle materials gained higher average score than usual practical learning. But the difference between the average score of the experimental class and control class was not significantly different. It is because the equation using practical methods in both classes. Trowbridge, et al. (2000) suggests that the practicum activities on science learning play an important role in facilitating students to develop science process skills [26]. Subiantoro (2010) states that through science practicum students have opportunities to develop and apply the science process skills, scientific attitudes in order to acquire knowledge [5].

The results of this study were supported by previous studies conducted by experts. Karamustafaoğlu (2011) states that the students’ science process skills thrive in learning using I Diagrams methods [27]. Furthermore, I Diagrams described as application and evaluation material which enable students to understand scientific research thoroughly and organize experimental activities used for science process skills. Downing & Filer (1999) reveal that after following the course of the scientific method and basic mathematical science, process skills of students of prospective elementary school teachers in Western Illinois University has significantly increased [28]. There was also a correlation of science process skills and attitudes towards science. Chien and Chang (2011) state that science process skills can be applied not only to the science practicum, but also others practicum such as information technology [29]. Wardani (2008) states that science process skills and thin layer chromatography learning concept understanding increased through micro-scale practicum activities [30]. Kruea-In &Thongperm (2013) state that their training on science process skills were most responsible for supporting the students’ performance skills [31]. Based on these studies, students’ science process skills can develop through practical activities and science process skills training.

Measured students’ science process skills in this study were basic science process skills not the integrated science process skills. It because students’ internal factors that caused they did not understand the science process skills. Prajoko et al (2016) reveals that students' understanding of science process skills are still low [23]. Thus it needs to introduce basic science process skills before introducing the integrated science process skills. Basic process skills measured in this study were observing, communicating, planning experiments, predicting observations, and asking questions. Basic science process skills were measured in this study also appeared in the learning process. Students were guided and assisted to use students’ work sheets to ensure the science process skills developed during the learning activities. Technically students’ work sheets have an important role in facilitating students to develop science process skills. In the control class that did not use students’ work sheet achieved lower science process skills score.

The use of recycle materials for practicum was significantly better than practicum which used laboratory kit. It was caused by several things. First, there was no laboratory facility and infrastructures that have challenged the students to find solutions to overcome those problems. Given the problems make students think higher (Bransford et al, 1986; Halpern, 1998; Snyder, 2008) [32]-[33]-[34]. Second, practicum with recycle materials will motivate students to do practicum activities so that they were much excited. Motivation was one of influential factors of the success learning activities (Tuan et al, 2005; Pintrich, 2003; Singh et al, 2002) [35]-[36]-[37]. Third, the use of recycle materials in practicum developed the students' creativity. Students’ creativity will be used to implement science process skills (Aktamis et al, 2008) [38].

Based on the questionnaire that obtained average score 2.82 out of a maximum score 3. The results indicated that students positively respond use of recycle materials in the science practicum. Some of the positive responses were saving the cost of practicum work, facilitate the practicum because it did not have to use the laboratory equipment and materials, students were directly involved in learning, increased creativity, more active in the practicum, improved the ability to think, triggered the curiosity, and easier to understand the science material. However there were also negative responses included the limited time to prepare equipment and unready practicum materials and some recycle materials were sometimes hard to find.

5. CONCLUSIONS AND SUGGESTIONS

Based on data analysis and discussion it can be concluded that the use of recycle materials in the science practicum significantly affect students' science process skills. It familiarized students by challenging them to solve the problem of the availability of practicum facilities and infrastructure. This leads to higher students' motivation in applying science process skills.Advice can be given based on the results of this research is the need to standardize the recycle materials to be used for lab practicum. Thus the science practicum would be safer.

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