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The effectiveness of volcanology learning through inquiry based on education for sustainable development

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ABSTRACT

Education is the most important thing to create the good quality human in the country. Surely, it can be realized through a good quality education. The purpose of this research is to develop geoscience based on Education of Sustainable Development (ESD) to train the college students' volcanology concept. The research for essential finding is a significant difference between the pre-test and post-test scores. Based on these scores, we obtain the n-gain score average is 0.69. So that, it can be known the average of the developed learning increase result is medium. Therefore, this develop geoscience learning can improve the college students' understanding about volcanology concepts.

1. Introduction

Education is a very important thing to creating the quality human resources and able to compete in facing future challenges. The quality of human resources can only be realized through a good quality education as well. The good quality education is education that is able to develop positive potentials that are latent in students. Through this quality education, education produces young workers who are tough, ready to compete in the world community, and contribute to technological development (Asymanidar et al.,2013; Widodo,2015; Amir&Arsyad,2015; Monalisa&Trapsilasiwi,2016).

In accordance with the objectives of the national education formulated in the Law on National Education System is "to develop the potential of students to become people who believe in and fear God Almighty,noble, healthy,knowledgeable, capable, creative, independent, and become democratic citizens and citizens who are democratic and to be responsible".Therefore,to improve the quality of Indonesian nation's resources can be done through improving the quality of education in Indonesia (Widodo, 2015; Manasikana & Anggraeni, 2018).

Achieving the quality of learning is the responsibility of a teacher and lecturer through the creation of meaningful learning experiences for students and the facilities obtained by students to achieve maximum learning outcomes (Sutikno,2007).In learning science, an indicator of the achievement of maximum results is the understanding of concepts that have been learned by these students (Hidayat et al., 2013: 23).

Science cannot be taught as a material of knowledge, but should be taught more through student center learning to realize meaningful learning. Thus, the involvement of students in learning is very important in the process of gathering information, evaluating, arguing, reasoning, and problem solving processes to obtain a decision from several choices (Eggert, et al., 2013; Hidayat, et al., 2013; Sinaga & Simajuntak, 2019).

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The science curriculum that has been formulated is very in accordance with the Indonesia conditions of earth, because it is inevitable that Indonesia is a country rich in natural disasters. Therefore, the associated social and economic impacts are currently increasing due to the catastrophic events (OCHA, 2014).

Volcanic phenomena become an inseparable part of Indonesian people's lives (Hariyono et al.,2016). Indonesia is one of the equatorial countries in the Pacific Ring of Fire. This Pacific Ring of Fire forms a horseshoe along approximately 40,000 km (12,000 miles) from south America to north America through the Japan Bearing Strait to New Zaeland. Along the ring of fire there are 452 volcanoes and 75% are active (Hariyono, 2016).

Therefore, geographically almost all regions in Indonesia are prone to natural disasters, especially volcanic disasters. Indonesia is one of the richest countries in the world in the number of volcanoes it has (Pujianto, et al.,2018). Indonesia has a large number of volcanoes in the world. There are 147 volcanoes, and 76 of them are active volcanoes and spread along the islands of Sumatra, Java, Sulawesi and the Lesser Sundas (Hariyono & Liliasari, 2018).

But in the reality, during the last century there were 429 natural disasters, more than 200 thousand people were killed, more than 29 million people were totally affected and the total damage was above 44 million US Dollars (EMDAT, 2016). The number of deaths was significantly caused by the natural gas disaster namely earthquakes and volcanic activity (Djalante, 2016).

These conditions have shown that the quality of Indonesian education related to geoscience learning is still low. One of the low quality of education in Indonesia is the low quality of teachers. This fact shows that education in Indonesia today faces many challenges and problems. Therefore, this condition can automatically have a direct impact on the graduates produced. The lower the quality of education, the lower the quality of graduates produced (Widodo, 2015).

An understanding of geoscience is very important for the community to successfully respond to these challenges and develop in the coming decades (Wysession et al., 2012). Based on the description above shows that geoscience learning is very important to improve science knowledge and concepts that are useful in everyday life and to develop skills, investigate the environment, and solve problems. Thus, it can improve disaster mitigation in Indonesian society and minimize the risk of disasters that occur.

Based on the results of tests to students of Physics Education in Academic Year 2019/2020, it is known that the students' have a poor understanding about volcanology concept. Their scores of the volcanology concept test were less tahan 50.

Supported by research conducted by Hariyono et al. (2016) in the Department of Physics, Surabaya State University, it is known that prospective physics teachers have a low understanding of volcanic material and there are several problems associated with the concept of volcanoes. Another fact is that learning geoscience does not support the formation of geoscience knowledge and skills, is dominated by theoretical studies and lacks focus on efforts to prepare students for disasters especially volcanic eruptions.

Based on the gap above, various considerations and efforts to transform vulnerable communities into communities that are resilient to terrestrial disasters currently require geoscience learning that is able to equip physics education students by integrating sustainable geoscience competencies (Sukasni & Efendy, 2017).

Education for sustainable development (ESD) based learning is action-oriented learning, which supports independent learning, participation and collaboration, problem orientation, inter-and transdisciplinary and connects formal and informal learning (Tang, 2017). Based on these statements, guided inquiry model is very appropriate with ESD learning. This learning model train the students to identify the problems, then do collaboration with their friend to answer the finded problems. In this case, the problem are the science earth issuess. guided inquiry model can improve mastery of concepts, scientific attitudes and science skill of science (Putra et al.,2016; Gumilar et al.,2019). This study is reconstructing the geoscience learning based on the Education for Sustainable Development (ESD). The purpose is to train the students' volcanology concept which support their disaster mitigation.

2. Method

This research was applied to 32 Students of Physics Education State University of Surabaya who is taking a course in earth physics. Before the learning design was applied to them, it was validated by two expert lectures in Department of Physics, State University of Surabaya. The method that was used in this research is one shot case study.

This experimental design is a design that is applied just to one group, without a comparison group. In this study design, the treatment for the students is learning media based on volcanology to the earth physics learning with applied the guided inquiry model. Furthermore, the results obtained pre-test and post-test understanding of volcanology concepts.

The assessment instrument consisted of 10 three tier multiple choice questions, which consists (1) possible answers, (2) open reasons, and (3) it's level of confidence. The indicators of this instrument are given by Table 1.

Table 1
The indicators of the assessment instrument about volcanology concept

Question Number	Indicators
1	Analyse the phenomena of volcanic formation in a convergent manner.
2	Predict the volcano shape based on the magma viscosity and gas pressure in the magma chamber.
3	Analyse the magma characteristic.
4	Analyse the types of volcanic eruptions based on the rheological nature of magma.
5	Analyse the types of volcanic eruptions based on the rheological nature of lava.
6	Analyse the types of eruptions based on the magma viscosity and gas pressure in the magma chamber.
7	Analyse the natural signs to determine the volcanic activity.
8	Explain the eruption volcano parameter.
9	Analyse the volcano activity based on the eruption volcano parameter.
10	Analyse the geography information to develop students' decision-making skill of volcano eruption.

Meanwhile, the students' answers were corrected by using the following rubrics. Table 2 is given the rubric answer of the volcanology concept question.

Table 2
The Assessment instrument rubric.

The rated aspect	Score	Description
Possible answer	1	Correct answer
	0	Un-correct answer
Reasons	4	The reasoning description is relevant to the correct answer and the statement is written correctly and completely.
	3	The reasoning description is relevant to the correct answer, but the statement written is incomplete or wrong.
	2	The reasoning description is not relevant to the correct answer, but the statement is correct.
	1	The reasoning description is not relevant to the correct answer and the statement is un-correct.
	0	No give reasons.

The final pre-test score and post-test score will be calculated by

using N-gain score to find out the students' increased understanding about volcanology concept between before and after learning. N-gain equation is given in equation 2 (Hake,1998).

$$\langle g \rangle = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \quad (1)$$

Where, ⟨g⟩ is the increased students' understanding, $S_{post}$is post-test score, $S_{pre}$is pre-test score, and $S_{max}$is the maximum score.

The obtained N-gain score then was interpreted on Table 3, so that we can know the criteria of their increased understanding.

Table 3

The criteria of N-gain score (Hake,1998).

N-gain score	Criteria
0.70 < N-gain	High
0.30 ≤ N-gain ≤ 0.70	Medium
N-gain < 0.30	Low

In addition to that, also be analysed the correlation between the students' conception and their attitude based on Education for Sustainable Development (ESD) through questionnaire. The analysis used Pearson Product Moment (if the data distribution is normal). Meanwhile, if data distribution is not normal used Spearman Rank Correlation analysis. Kolmogorov-Smirnov Test is used the test distribution. Table 4 give the students' attitude based on Education for Sustainable Development (ESD).

Table 4

The students' attitude in the questionnaire.

Attitude	Statements
1	My understanding about the conditions and characteristics of the environment around me is better through the geoscience course.
2	By studying geoscience courses, I want to deepen my knowledge regarding the various potential disasters and earth phenomena that occur around me.
3	In the geoscience course, I want to learn scientific explanations related to earth disasters that have the potential to occur in the environment around me.
4	I want to know the various steps that can be done with earth disaster mitigation.
5	After this study, I want to give my abilities and talent to reduce the impact of earth disasters.

3.Result and discussion

This research used guided inquiry model based on Education for Sustainable Development (ESD). The ESD was integrated in the all of syntax of guided inquiry learning model. Table 5 explain the ESD in the guided inquiry model which is applied.

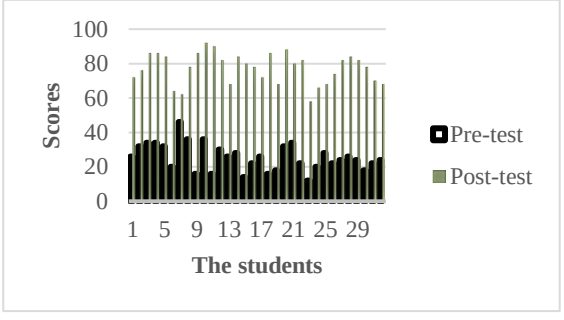

Fig. 1. The students' score of their understanding about volcanology concept

Based on the Fig. 1 above, there is a significant difference between the pre-test and post-test scores. The higher score of the pre-test is only 46, while the post-test is 92. The higher post-test is twice of the higher pre-test score. Whereas the lower pre-test score is 12, and the lower post-test score is 58. In addition to that, the average of the pre-test score is 25.5, while post-test score has average 77.3. Therefore, it can conclude that the post-test score is better than the pre-test score, so that the college students' understanding about volcanology concept produce the same results.

In addition to that, we also need to know about the level of the increase of the pre-test and pots test. The steps that can be done is calculate the n-gain score of them by using Equation 2. Then, the calculating result was interpreted into the Table 3. The calculating result of the n-gain scores are given the following Fig. 2.

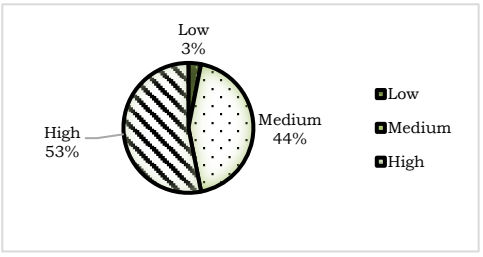

Fig. 2. The distribution of the students' N-gain score

Fig. 2 gives information that the majority of criteria increase between the pre-test and post-test scores is medium and high. If all of these scores are averaged, we obtain the n-gain score average is 0.69. Based on the value, it can be known the average of the developed learning increase result is medium. Therefore, the reconstruction geoscience learning success to increase the college students' understanding of volcanology concept. The volcanology concept is very influential for the soul of eruption disaster mitigation. If the students have good understanding about the volcanology concept, so their disaster mitigation is good too.

This result is supported by Hariyono et al., (2015) research about the application of the science curriculum model by integrating disaster mitigation and management. The result is that students have good knowledge of disaster mitigation and response techniques. In addition to that, the students can describe the potential for disaster as well as mentioning what activities cause disasters in coastal areas. This shows that through sustainable learning can practice good disaster mitigation and management.

Education for Sustainable Development (ESD) competencies can indeed have an impact on student outcomes in terms of their awareness of sustainability. The results of this study reveal the key role of ESD in addressing sustainable development, so that it can answer the challenges future (Pauw et al., 2015).

As the science lecture or science teachers must always develop and do reconstruction the geoscience learning based on the current problem issues. The purpose is to create the good quality geoscience learning, so that the students have good understanding about geoscience concept and can increase the disaster mitigation.

Based on the Kolmogorov-Smirnov Test, we obtained that the test distribution is normal. Then, we used the Pearson Product Moment correlation to identify students' volcanology concept and their ESD skills. The ESD skills The ESD skills are covered by the students' five attitudes about volcano disaster mitigation. The results are given by Table 6.

Table 6 shows that the volcanology concept is not correlated with the students' attitude of volcano disaster mitigation. On the other hand, there is an attitude which correlated with another attitude, i.e.

"I want to know the various steps that can be done with earth disaster mitigation" and "After this study, I want to give my abilities and talent to reduce the impact of earth disasters". So, we know that the students' knowledge about the step mitigation correlate with their appetency to reduce the disaster impact. Therefore, the students need to learn about how the step mitigation so that the disaster impact can be overcome.

Based on the research results above, we were obtained that through this geoscience learning reconstruction based on Education for Sustainable Development (ESD) can increase the students' understanding about volcanology concepts. In other hand, their attitude outcomes are good about the sustainable earth issues. So that, this learning is effective. This research results are corresponding with Akker et al.(2013) which state that "The effectiveness of learning is using the intervention is expected to result in desired outcomes".

	Volcanology concept	Attitude 1	Attitude 2	Attitude 3	Attitude 4	Attitude 5
Volcanology concept	-					
Attitude 1	0.442	-				
Attitude 2	0.393	0.292	-			
Attitude 3	0.125	0.090	0.358	-		
Attitude 4	0.755	0.981	0.405	0.294	-	
Attitude 5	0.510	0.502	0.248	0.052	0.000*	-

Table 6
The students' volcanology concept and their ESD skills
*p<0.05

4.Conclusion

The result of developed geoscience learning reconstruction based on Education for Sustainable Development (ESD) was obtained that it can improve the college students' understanding about volcanology concepts. A manner which is can be needed to reconstruct learning that can answer future challenges is ESD-based learning. So that, this geoscience learning reconstruction was effective to do. Therefore, it can create the next generation of a strong nation, ready to compete in the world society.

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