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Integrating Disaster Risk Reduction with Science Education to Student of Junior High School in Merapi Mountain Areas, Indonesia

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Abstract

This study aimed to find out how to integrate disaster risk reduction efforts with natural science subjects and prove the success of the integration. This research begins by developing learning tools that can facilitate the implementation. After the developed tools are feasible to be used, an implementation is conducted to 59 students in Merapi Mountain Areas to prove the success of integration. From the result, it turns out that integration with science subjects has proven to be able to increase students' preparedness in facing disasters.

Keywords:

I. INTRODUCTION

Indonesia is one country that has a high risk of volcanic eruption disaster. This is due to the location of Indonesia which is located at the confluence of three world lithosphere plates, namely the Indo-Australian plate, the Eurasian plate and the Pacific plate. The meeting of the world's three lithosphere plates causes Indonesia to be traversed by two world mountain paths, namely the Mediterranean Circum and the Pacific Circum. Indonesia's territorial area lies in the magma line called the Pacific Ring of Fire. Thus, Indonesia has a lot of active volcanoes, with a total of 129 active volcanoes, or 17% of all active volcanoes in the world [30].

One of the most active volcanoes in Indonesia is Mount Merapi. Administratively, Mount Merapi is located in four districts, namely Sleman Regency in the Special Province of Yogyakarta, Magelang Regency, Boyolali Regency, and Klaten Regency in Central Java Province. Mount Merapi has become the center of world attention due to its eruptive activity. The mountain which is one of the active volcanoes in the world experienced a severe eruption in 2010 which lasted for almost 2 weeks. The eruption was recorded as the worst disaster caused by the eruption of Mount Merapi in the last 100 years, or since 1870 [12].

The eruption caused the loss of lives and property. Based on National Disaster Management Authority of Indonesia's data, up to December 2nd 2010 the number of victims reached 242 people in the Special Region of Yogyakarta and 97 people in the Central Java region, with a total of 1,438 injured. Meanwhile, as many as 303,233 people were displaced [3].

Damage caused by the eruption of Mount Merapi has an impact on various sectors, including settlements, infrastructure, social, economic, and cross-sectoral resulting in disruption of public activities and services. According to data compiled by National Disaster Management Authority of Indonesia, up to December 31st 2010 based on the results of the damage and loss assessment, the eruption of Mount Merapi has resulted in damage and losses of 3,628 trillion Rupiahs, divided into productive economy, infrastructure, housing, cross-sectoral, and social sectors.

The high risk of volcanic eruption disaster should be balanced with preparedness. But, Said & Chiang (2019) [24] stated that there were still some aspects of low preparedness, such as lack of knowledge about types of disasters due to lack of training, lack of skills, and lack of willingness and awareness of the importance of being prepared. Indonesia is a country with the fifth largest population in the world, but the knowledge of its people cannot reflect as a society that has an attitude of being prepared for disasters [14].

As one of the three countries with the best level of disaster preparedness in the world, New Zealand has developed an operational security system before an emergency occurs, while New Zealand also emphasizes community resilience. This is because the community is the main component affected by the disaster. New Zealand has a preparedness campaign program aimed at elementary and secondary school students [22].

Schools are one of the most risky sectors, but schools also have the potential to be a means of building community resilience, which naturally starts from students' awareness of the importance of disaster preparedness. Students need habituation related to disaster preparedness. This is related to the psychological condition and self-confidence of students. To realize students who are accustomed to being prepared, it takes training in daily life [18].

Brewer, Hutton, Hammad, & Geale (2020) [6] defines that there are four aspects that must be emphasized in disaster risk reduction activities, namely knowledge about demographics and environmental characteristics, knowledge, skills, and post-disaster preparation. While, Ilo, Izuagbe, Mole, & Ekwueme (2018) [17] defines that there are four aspects to disaster risk reduction, namely knowledge and attitudes towards disaster preparedness, response in the event of a disaster, preparation for preparedness, and availability of resources.

Students are components of society that are considered capable of making changes to the surrounding environment. So, it is very appropriate to equip students with disaster knowledge at school [20]. One appropriate effort is to integrate efforts to reduce disaster risk with the curriculum and subjects in schools [21; 25].

One of the subjects that has the potential to be integrated with

disaster risk reduction efforts is natural science. The natural sciences curriculum in 1st grade of Junior High School includes basic competencies regarding the earth's layers, volcanoes, earthquakes, and disaster risk reduction. However, the focus of learning on disaster risk reduction should be specified according to the characteristics of the student's area of residence. It aims to make students really recognize the characteristics of disasters in their area, to then have an attitude of being prepared to face the disaster [8].

One effort that can be done in the integration of disaster risk reduction efforts with natural science learning is to develop science learning tools that can facilitate integrated learning activities of volcanic eruption disasters. With the learning tools, it is expected that the teaching and learning activities that take place can be focused, so that students truly benefit, both in terms of science content and in terms of disaster preparedness.

I.I Environmental Setting of the Study Area

The study was conducted at 2 Cangkringan Junior High School, which is approximately 8 km from the peak of Mount Merapi. Administratively, 2 Cangkringan Junior High School is located in 1st disaster prone areas to the eruption of Mount Merapi. Students at 2 Cangkringan Junior High School come from the area around the school, so it is appropriate to carry out the application of the integration of disaster education with learning in this school, because it is expected that the benefits can be directly felt by students.

II. METHODS AND MATERIALS

This study consists of two core sub-activities, namely the development of integrated science learning tools for volcanic eruption disasters and the implementation of learning tools developed. Development of learning tools refers to the 4-D development model by Thiagarajan, Semmel, & Semmel (1974) [27] with the following stages of development.

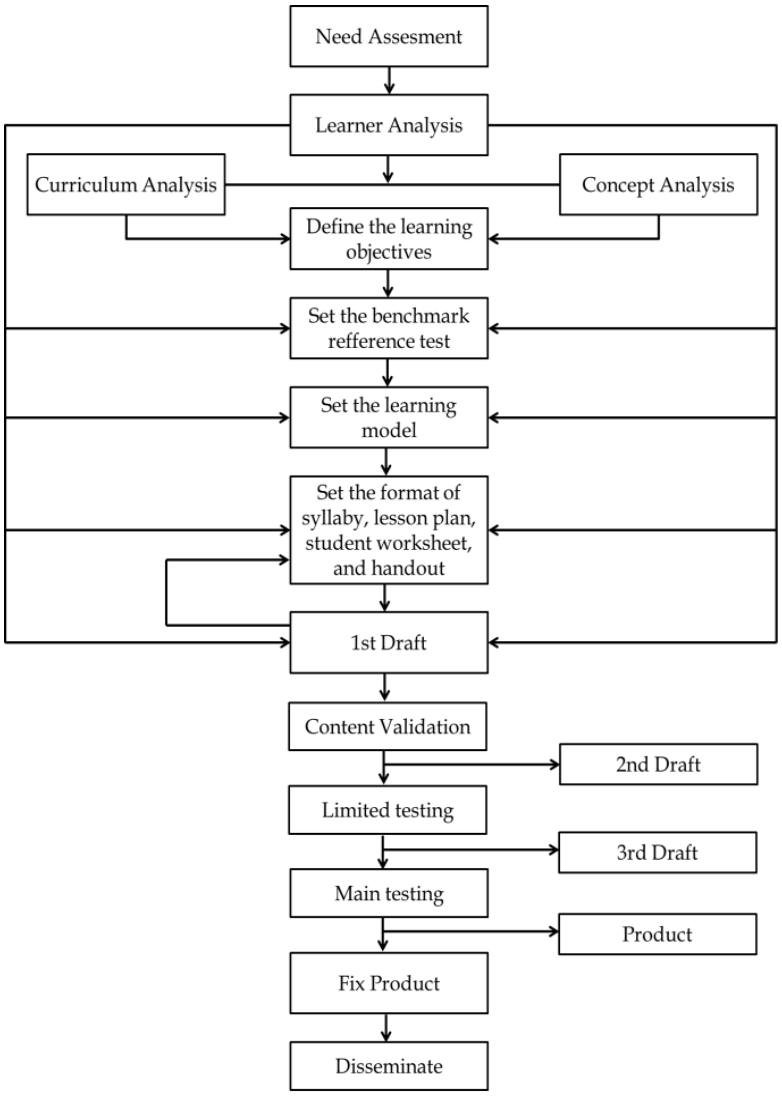

Figure 1. Stages of Learning Tools Development

After the product has been categorized as feasible to implement, the product is implemented in class to measure the success of the integration of disaster learning. To prove the successful integration of disaster learning, an assessment of student preparedness tests is carried out before and after implementation.

II.I Analysis

Products developed go through stages of validation by experts. The scores obtained are then averaged. The average end result is classified according to the product rating categories according to Howell (2007) [16] as follows.

Table 1. Product Rating Category Classification

No	Average Interval Score	Category
1	$3.25 < x \leq 4.00$	*Very good*
2	$2.50 < x \leq 3.25$	*Good*
3	$1.75 < x \leq 2.50$	*Low*
4	$1.00 < x \leq 1.75$	*Very low*

One of the successful implementation of the integration of disaster risk reduction efforts with natural science learning is seen from the improvement of student preparedness through tests. The test results are processed then classified according to the gain score category according to Hake (2002) [13] as follows.

Table 2. Gain Score Category

No	Gain Score	Category
1	$(\langle g \rangle) \leq 0,3$	Low
2	$0,3 < (\langle g \rangle) \leq 0,7$	Moderate
3	$(\langle g \rangle) > 0,7$	High

III. RESULTS AND DISCUSSION

III.I How to integrated?

Ideally, disaster risk reduction efforts are carried out systematically throughout the curriculum and at all grade levels. This is so that messages in disaster risk reduction efforts are conveyed holistically along with knowledge, skills and attitudes that must also be achieved as part of the learning objectives. Selby & Kagawa (2012) [25] carrying out case studies related to disaster risk reduction efforts in the curriculum of thirty countries in the world. The following information is obtained relating to the frequency of subjects integrated with disaster risk reduction efforts.

Table 3. Disaster Risk Reduction Curriculum Integration Summary

Carrier Subjects	Frequency
Natural Science Cluster	20
Social Science Cluster	12
Geography	11
Language Cluster	10
Civic and Citizenship Education	5
Heath and Physical Education Cluster	4
Technology Cluster	4
Life Skills Cluster	3
Dedicated Subject	2
Pre-military Education	1
Civil Defence	1
Agriculture	1
All Subjects	2

Based on the data above, it is known that the subject that is most often the carrier for disaster risk reduction efforts is natural science. Therefore, natural science has the potential to become one of the integration platforms for disaster risk reduction. In this case, the material taken by researchers is material related to the layers of the earth, volcanoes, earthquakes, and disaster risk reduction measures.

Petal (2008) [19] defines that the integration of disaster risk reduction efforts into subjects begins with the identification of needs, the integration of information and problems to be solved, the preparation of content, and the preparation of learning strategies that are fun. The step that can be done is to do a needs analysis. Thus, the product can be used appropriately. Reflecting on this, the following is the scheme used by researchers in integrating disaster risk reduction efforts with natural science lessons.

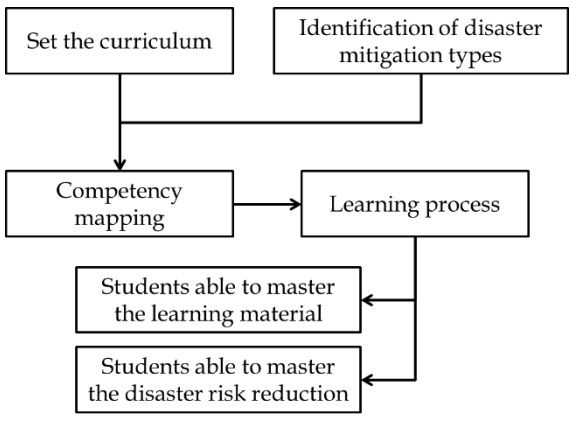

Figure 2. Disaster Risk Reduction and Science Education Integration Scheme

The integration of volcano eruption disaster risk reduction with science learning is realized through the development of learning tools. The learning tools developed consist of syllabus, lesson plan, student worksheets, and handouts. Learning tools developed were assessed by experts and learning practitioners. The results of the assessment of experts and learning practitioners are as follows.

Table 4. Product Feasibility Assesment

No	Product	Average Score	Category
1	Syllaby	3.945	Very Good
2	Lesson plan	3.985	Very Good
3	Student worksheet	3.745	Very Good
4	Handout	3.685	Very Good

Overall, based on these results it can be seen that the products developed are included in the excellent category. The specifications of each product developed are as follows.

III.I.I Syllaby

The syllabus is a reference for the preparation of the learning framework which is a translation of the competency standards and basic competencies as a result of selection, grouping, sorting, and presenting curriculum materials developed [2].

Syllaby that was developed refers to the syntax of discovery learning models. In general, learning activities are divided into three main activities in three meetings. At the first meeting, students study the structure of the earth, plate shifts, volcanic formation, and volcanic characteristics. At the second meeting, students learn the signs and stages of volcanic eruptions, disaster risk reduction efforts, and actions to save themselves. Meanwhile, at the third meeting the students studied the impact of the volcanic eruption on the biotic and abiotic ecosystems. Learning activities undertaken by students in more detail are outlined in the lesson plan.

III.I.II Lesson Plan

Lesson plan is a plan that describes the procedures and organizing learning to achieve a basic competency set out in content standards and outlined in the syllabus. The broadest scope of the lesson plan includes one basic competency consisting of one indicator or several indicators for one or more meetings [11; 32]. The learning model used is the discovery learning model.

Discovery learning model requires students to be able to construct their own concept of knowledge, so that the knowledge obtained by students will increasingly imprint [1; 5; 23; 33]. The selection of discovery learning models is based on the syntax of the discovery learning model which consists of a stimulation stage, problem statement stage, data collection stage, data procession stage, verification stage, and generalization capable of facilitating the implementation of learning integrated with disaster risk reduction efforts.

III.I.III Student Worksheet

Student worksheet aims to guide students to develop a conceptual framework of topics that are considered difficult and overcome their difficulties. Student worksheet contains questions that require students to use scientific reasoning in building their conceptual understanding. In the implementation, students will be divided into groups consisting of several students to work on student worksheet which are also assisted by other references that support [4].

Student worksheet makes students easy to construct the concept of knowledge. The advantages of student worksheets that are developed include learning activities carried out by students arranged in a directed manner making it easier for students to understand the level of material. In addition, this student worksheet is equipped with pictures, charts, and tables that are interactive and communicative, making it easy for students to answer questions in accordance with the activities required.

Student activities begin with stimulation. Stimulation activities aim to provide stimulus to students related to the problems they face. The next activity is the formulation of the problem. Students are faced with problems that can be seen from video shows, animations, and learning articles then students collect data relating to solutions that may be offered for existing problems. In collecting data and answering questions students are allowed to look for as many references as possible. After verifying, students make generalizations and draw the concepts of learning obtained.

Variations in learning activities carried out consist of discussion, practical work, presentations, and simulations. At the second meeting, students are faced with an unexpected simulation activity where the teacher will turn on the early warning system to then observe the student's behavior and preparedness response such as if a disaster really happened.

III.I.IV Handout

Handout help learning activities by connecting students' initial knowledge with knowledge that will be conveyed by the teacher [7]. The handout that was developed has several advantages. In addition to focusing on the material for disaster risk reduction, the handout contains important information rubrics relating to rescue. The handout comes with a glossary that lists foreign terms. The handouts are also equipped with images that support material as well as barcodes that can be scanned with smart phones, so students can gain additional knowledge from the video.

III.II Is it really integrated?

Integration of disaster risk reduction efforts with learning is a conscious and planned effort in the teaching and learning

process, in order to empower students as an effort to reduce disaster risk and build a culture of disaster resilience. Disaster risk reduction actions are manifested in a number of sustainable scenarios, which are carried out just before a disaster occurs, immediately during a disaster, or after a disaster.

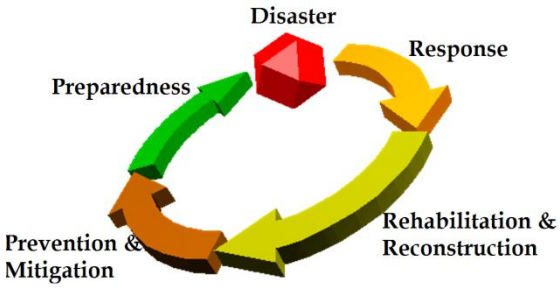

Figure 3. Disaster Risk Reduction Cycle

The integration effort taken is included in the preparedness stage. The activities carried out include the introduction of disaster threats, types of threats, risk analysis, making risk maps, evacuation routes and signs, training in self-rescue, and disaster simulations. Gall, Nguyen, & Cutter (2015) [10] defines that one of the factors triggering the successful integration of disaster risk reduction efforts is the existence of discipline and support from stakeholders. While, Spiekermann, Kienberger, Norton, Briones, & Weichselgartner (2015) defines that there are stages that must be taken to achieve successful integration of disaster risk reduction, ranging from understanding, knowledge, meaning, to achieving insight and intelligence.

To prove the successful integration of disaster risk reduction with science learning, one of the factors seen was an increase in students' preparedness before and after implementation. Implementation of learning tools developed was carried out on 59 students of 1st grade. Preparedness test assessment measures four aspects of preparedness that are adapted from *Hyogo Framework* [28; 29] that consist of knowledge and attitudes towards disaster risk, early warning systems, plans for disaster emergencies, and resource mobilization. The results of the test assessment are as follows.

Table 5. Implementation Assesment Result

Pre Score	Post Score	Gain Score	Category
45.76	73.53	0.51	Moderate

Based on the above table, it is known that there is an increase in student preparedness caused by the implementation of disaster risk reduction efforts integrated with natural science learning. One of the factors supporting the successful implementation is that most of the students in the trial schools reside in disaster prone areas. Wilujeng, Prasetyo, & Suryadarma (2017) [31] stated that learning integrated with something that is closely related to students' daily lives will be more meaningful. Support this, Hiwasaki, Luna, & Shaw (2014) [15] emphasizing the integration of local potential with disaster risk reduction efforts. In its implementation, curriculum must be compiled at the national level as a standard or reference for the preparation in order to facilitate and provide guidance for teachers regarding what teachers must do in the learning program. The national curriculum serves as a guideline for what teachers must do in raising awareness of hazards and disaster preparedness [21,31].

Research conducted by Dwiningrum, Prihastuti, & Suwarjo (2017) [9] teachers and secondary school students in Yogyakarta show that in an effort to increase school involvement in disaster mitigation, good knowledge is needed. One effort that can be taken to achieve good knowledge is the integration of disaster risk reduction efforts in subjects. Overall, the integration of disaster risk reduction efforts in science learning as has been done by researchers is recommended to be implemented in other regions with similar potential disasters. However, continued research and in-depth studies are still needed for the effort to acquire ever-expanding knowledge.

IV. CONCLUSIONS

Disaster risk reduction efforts are activities carried out before a disaster occurs. People who choose good disaster resilience will be able to respond to disasters wisely, in addition, will be able to determine the right and safe steps to save themselves and those around them. One of the main factors in the successful implementation of disaster risk reduction efforts is public awareness of the importance of preparedness. Building community awareness can start from school. Children who are accustomed to disaster preparedness, are believed to be able to grow into disaster resilient adults.

Habits living harmony with disasters can be implemented from the school age. One effort that can be done by schools is to integrate efforts to reduce disaster risk with the curriculum, one of which is natural science subjects. This research has succeeded in developing learning tools that contain disaster risk reduction efforts integrated with natural science lessons. The learning tools developed consist of syllabus, lesson plan, student worksheets, and handouts. After implementation, it turns out that the integration of disaster risk reduction efforts with science lessons is able to increase students' preparedness knowledge.

Disaster risk reduction efforts are continuous efforts, which must be continuously trained and accustomed to students. As citizens who live in the Pacific Ring of Fire, it is appropriate for Indonesia to implement the integration of disaster education with lessons in schools, in order to realize disaster resilience early on. Required support and synergy from various parties, ranging from the government, teachers / learning practitioners, parents, community, researchers, and developers of learning tools. With this research, it is expected to be able to be a reference for teachers, learning practitioners, and learning device developers to be able to develop similar devices with other types of disasters, to support disaster risk reduction efforts from the education sector.

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