



## THE RECONSTRUCTION OF DISASTER KNOWLEDGE THROUGH THEMATIC LEARNING OF SCIENCE, ENVIRONMENT, TECHNOLOGY, AND SOCIETY INTEGRATED WITH LOCAL WISDOM

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### ABSTRACT

This study aimed to improve the mastery of knowledge, attitudes, and skills of students in disaster mitigation in prone areas of volcanic eruptions. The subjects of this research were fifth (V) graders in three elementary schools situated in prone areas of Merapi volcano eruption in Srumbung subdistrict, Magelang regency, Central Java. The data collected in this study consisted of disaster knowledge, attitude, and disaster mitigation practice. The data of disaster knowledge were obtained through a test and analyzed using t-test and N-gain. The attitude data were collected using questionnaire with an improvement analysis using N-gain. The mitigation practice data were collected through observation and analyzed by descriptive percentage for attitudes and skills. The research results showed that the implementation of thematic learning of Science, Environment, Technology, and Society (SETS) integrated with local wisdom was able to reconstruct and increase the disaster management knowledge. This can be seen from the N-gain score obtained by each elementary school which the highest Gain Score was 0.46 and included in the medium category. There was an enhancement attitude toward disaster having the highest Gain Score was 0.77. All disaster mitigation indicators were successfully mastered by more than 70 percent of the students, who were in the good category ( $70 \geq X \leq 85$ ) in all three elementary schools implementing the thematic learning of SETS integrated with local wisdom.

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Keywords: disaster, local wisdom, reconstruction, thematic learning

### INTRODUCTION

Climate change occurred in many regions in the last five years has resulted in various disasters. Disaster is a natural event to watch out for. Global climate change also affects all areas including Indonesia. Many disasters frequently happen in Indonesia are floods, earthquakes, landslides, and volcanoes. Indonesia archipelago has a very high disaster potential which varies greatly on disaster types. The application of plate tecto-

nic theory for the Indonesian is due to its location on a crustal plate clash of the Eurasian / Southeast Asia, Pacific, and the Indo-Australian. In addition to the complexity of demographic, social and economic conditions in Indonesia that contribute to the high level of community vulnerability to disaster threats, as well as the people's lack of capacity in dealing with disasters, Indonesia has a high risk of disaster. In 2017, volcanic eruptions occurred several times just as at Karo District, North Sumatera. The high-level intensity eruption of Sinabung Mountain, for instance, happened twice on Saturday, May 20, 2017, and

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Wednesday, August 2, 2017. Another eruption took place at Gunung Agung in Bali province which also erupted on Tuesday 21 November 2017 at 17.05 WITA. The high intensity of volcanic eruption disaster is caused by the number of active volcanoes in Indonesia. Indonesia has 127 active volcanoes scattered on large and small islands. The big number of active volcanoes in Indonesia as it lays on the Pacific ring of fire.

Indonesia's geographical position on the Pacific Ring of Fire causes the high level of volcanic eruptions (Siagian et al., 2014). The volcanic eruptions have a long-term impact. The burst of volcanic materials could alter the existing ecosystem in the slopes. In addition to the environmental impact, volcanic eruptions also affect the people's social life. One of the mountains with a high level of activity in Indonesia is Mount Merapi (Carr et al., 2016; Troll et al., 2015). Mount Merapi is situated on the border area of Central Java and the Special Region of Yogyakarta. Up to now, Mount Merapi has erupted more than 80 times, once every 4 years on average. The last eruption of Mount Merapi occurred in 2014 having 347 casualties. The area with the highest number of casualties was Sleman Regency (246 people), Magelang District (52 people), Klaten (29 people), and Boyolali (10 people). Moreover, the refugees due to the Mount Merapi eruption were 410,388 people (Renatama, & Suryono, 2015; Susilo & Rudiarto, 2014).

Due to Merapi's high intensity of eruption and its large number of casualties, it requires concrete steps to diminish the risk and casualty number. One of them is by transferring the knowledge about disaster alertness in schools through learning activities. The lesson about disasters is certainly different from the ordinary lesson that does not include such knowledge (Rusilowati et al., 2012). Disaster learning should be designed considering the disaster-prone areas, disaster characteristics and early knowledge about disasters. Basically, the people living in disaster-prone areas already have unpretentious knowledge on disaster management which is hereditarily derived from older family members. This acquired knowledge is both facts and myths, which generally can be elucidated scientifically. However, some myths flourish in the certain area.

One of the efforts to fix, reconstruct and improve community's disaster knowledge is through disaster education at schools (Tasic & Amir, 2016; Dwiningrum, 2017). In line with this, knowledge reconstruction, attitude, and

competence of disaster mitigation improvement of the people living on slopes of Mount Merapi through the series of school activities were undertaken. Disaster education activities in schools through learning activities require a learning design integrating disasters, knowledge of the community, environment, technology, and local wisdom. To realize it, the learning of Science, Environment, Technology, and Society (SETS) integrated with the local wisdom is one of the solutions. The SETS thematic learning educated the students to linkage the science concepts with other elements in SETS. Such a way allowed the students to gain a clearer description of the learning conceptual association with other SETS elements both the advantages and disadvantages (Binadja, 2005). The integration of local wisdom in the lesson could be implemented in some subjects. The first thing to be doing is mapping the subjects to which the SETS learning is applicable. This has to be carefully undertaken to result in a harmonious integration without any overlapping. (Setiawan et al., 2017; Rusilowati et al., 2015; Andriana et al., 2017).

Similar research has been done by Setiawan et al. (2017), who developed a local wisdom-based Natural Science module to enhance students' science literacy. Furthermore, an article written by Rusilowati et al. (2015) discusses how to apply the SETS thematic learning in teaching disaster knowledge integrated with local wisdom. While in this research, the SETS thematic learning integrated with the local wisdom of Merapi eruption-prone areas was taught thematically in elementary schools. This SETS thematic learning facilitated teachers in explaining disasters comprehensively from science, environment, technology and society perspective, and was integrated with the local wisdom. Thus, the students could get better, comprehensive and deep knowledge about disasters especially Mount Merapi eruption.

This disaster learning was designed by combining the science, technological, and social elements. The science elements serve to equip students with sufficient knowledge about natural disasters and signs of changes in nature seen from the science perspectives. The science element is then followed by some avoided environment conditions preceding a disaster. On the other side, the technological elements function to inform about technologies employed to detect the occurrence of a disaster so as

to generate the right response and attitude. In addition, the social elements serve as a role in providing students knowledge about the adaptation in pre-, while-, and post-disaster.

This disaster learning was implemented among elementary school students having the learning tools consisted of the syllabus, instructional plan, teaching materials, learning method, and evaluation device. The research done by Amri et al. (2017) and Sakurai et al. (2018) gave a disaster knowledge in a tsunami-prone area, resulting in resilient students toward tsunami. The difference between this learning and similar learning in the previous research lied in the grades to which the learning was applied. The prior research applied the disaster learning to elementary students grade IV, V, and VI, also, to junior high school students grade VII, VIII, and IX. In addition, the learning focused on how the teachers taught the integrated learning materials. Therefore, this research complements the prior study since it did not only emphasize on the way the teachers taught, but also the learning outcomes in terms of the students' knowledge, attitude, and disaster mitigation practice. In other words, the learning had broader domain knowledge. Also, the disaster learning was implemented only for V grade elementary students in accordance with the latest curriculum, resulting in a better application. Besides, the disaster learning in this research pointed to only a disaster which hea-

ded to specific, detailed, and in-depth learning materials.

## METHODS

This research was an experimental research having the research sample picked using the purposive sampling technique. This technique was adopted in accordance with the research purpose of implementing such learning in a specific area, particularly in disaster-prone areas of Mount Merapi eruption. The research sample was the fifth-grade students in three elementary schools located in the red zone (obliged to evacuate during the disaster) namely SD Negeri Kaliurang 1, SD Negeri Kaliurang 2 and SD Negeri Ngablak situated in Sumbing District Magelang Regency. In addition to those three primary schools, this study also involved one elementary school functioning as a control group, namely SD Negeri Sudimoro 1 which is also located in the same area. Therefore, the schools have the same characteristics of students, environment, potential and vulnerability level to the Mount Merapi eruption. This research was conducted in the Odd Semester, Academic Year of 2017/2018 from August to November 2017. The data types, data collection techniques, instruments, and data analysis techniques employed in this study are presented in Table 1.

**Table 1.** The Data Types, Techniques, and Data Collection Instruments

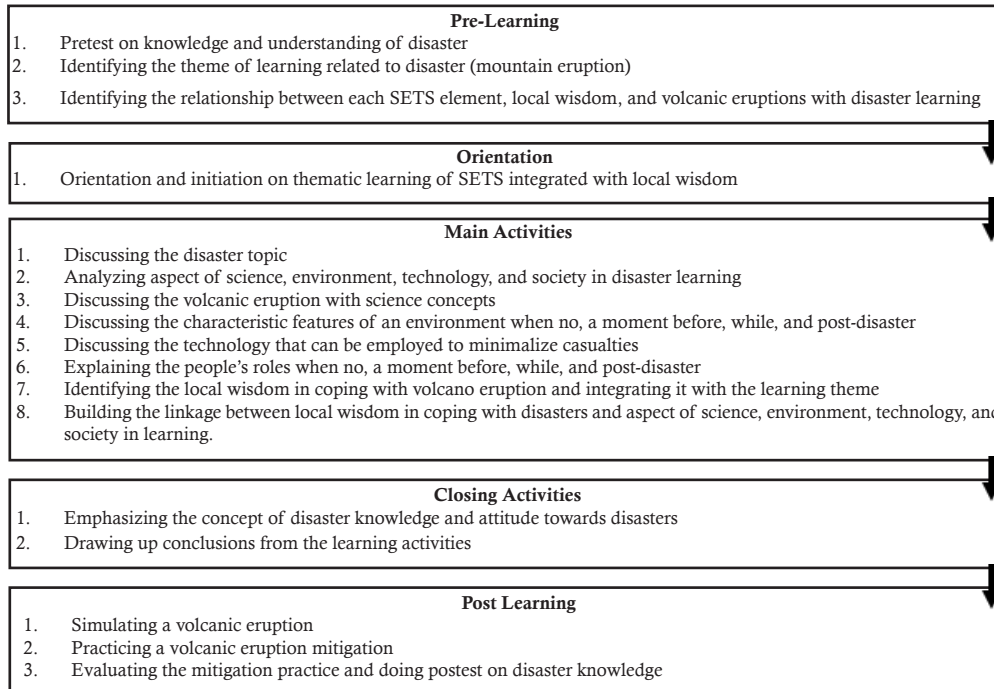
Data Types	Data Collection Techniques	Data Collection Instruments	Data Analysis Techniques
Knowledge	Test	Test questions	<i>t-test sampel related</i> <i>N-gain</i>
Attitude	Questionnaire	Questionnaire sheets	<i>N-gain</i>
Mitigation practice	Observation	Observation sheets	Descriptive Percentage

## RESULTS AND DISCUSSION

The SETS thematic learning integrated with local wisdom was arranged based on the theory of constructivism and behaviorism. Both kinds were the basis for the development of the SETS thematic learning integrated with local wisdom. These were the rudimentary theories in preparing lesson plans and materials related to cognitive aspects. By merging these two theories, the students having the intention and determination to learn something deeply would be really assisted since they were given detailed in-

formation and urged to practice the knowledge obtained. Hopefully, they could understand all the materials provided.

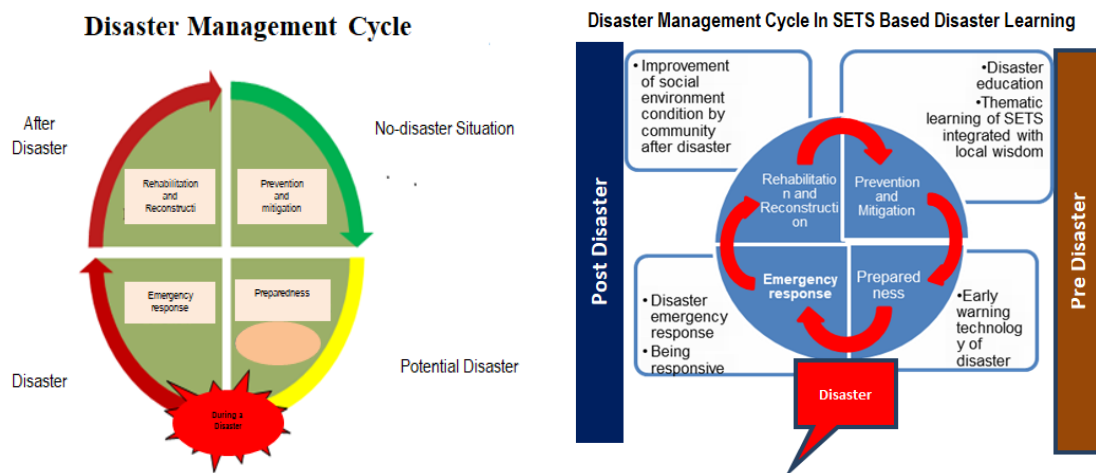
The learning activities of the Science, Environment, Technology and Society (SETS) thematic learning integrated with local wisdom focussed on a prevention and mitigation simulation when no disaster happened, which included in non-structural mitigation efforts. The stages of SETS thematic learning activities integrated with local wisdom can be seen in Figure 1.



**Figure 1.** The learning activities of SETS thematic learning integrated with local wisdom

Figure 1 tells that The SETS thematic learning integrated with local wisdom belonged to a volcano eruption mitigation effort. The disaster mitigation itself means a series of efforts to reduce disaster risks in the form of physical development, awareness development, and coping capacity improvement (Hemstock et al., 2017). Disaster mitigation consisted of two kinds of structural mitigation including development and disaster management on the physical aspect and non-structural disaster mitigation in the form of awareness and knowledge to improve people's co-

ping capacity. The non-structural disaster mitigation consisted of counseling, training, and disaster education. In a disaster management cycle, the thematic learning of SETS integrated with local wisdom comprised the prevention and mitigation efforts. These learning activities provided comprehensive knowledge about the prevention and mitigation of volcano eruption that must be understood and controlled by the community in disaster-prone areas. The position of SETS thematic learning integrated with local wisdom in disaster prevention cycles is visible in Figure 2.



**Figure 2.** Comparison of the Disaster Management Cycle

Figure 2 tells that the SETS thematic learning integrated with local wisdom acted as a complement to the disaster management cycle. This learning had a role in the formation of disaster concepts and knowledge for the students and communities living in the disaster-prone areas of Mount Merapi eruption. The disaster knowledge was provided at the pre-disaster stage which had an impact on preparedness, emergency response, rehabilitation, and reconstruction. In other words, the provision of disaster knowledge through this learning was a very important role in the formation of a resilient and responsive community to disasters happened in the areas. In Figure 2, it also appears that the disaster management cycles were divided into two; pre-disaster and post-disaster stage. The activity in Figure 2 is a series of activities undertaken to clarify and complete the previous disaster management cycle.

The activities during the pre-disaster started with the delivery of disaster knowledge through the thematic learning of SETS integrated with local wisdom. In these activities, the students were granted the basic disaster knowledge. The knowledge included the mastery of signs found before a disaster happens, the process of a disaster, how to save yourself from a disaster and what to do after a disaster occurs. All activities undertaken were linked to the concept of science, environment, technology, and society including the society's local wisdom in coping with disasters. The second activity was to identify and comprehend the early warning technologies that played a role in increasing knowledge for disaster prevention and mitigation. By mastering the disaster knowledge and mitigation skills, the students would shape their attitude toward disaster preparedness (Chou & Wu, 2014; Ishizuka, 2015; Liu et al., 2016). It appears in Figure 2 that disaster education through learning activities in the pre-disaster stage greatly affected the next activities conducted while and post-disaster. In other words, it was able to cultivate the students' and people's response to a disaster.

Equipped with strong knowledge and emergency response capabilities, it was expected that the students and communities become responsive during and after disasters (Erni & Edi, 2017). The difference between the research by Erni & Edi (2017) and this research was on the knowledge given. The prior study provided knowledge about the flood disaster in the watershed area of Semarang Central

Java, while this research gave disaster knowledge about Merapi eruption to students in the slopes of Mount Merapi, Magelang regency, Central Java. This volcanic disaster knowledge is very important for the students in the area. The provision of knowledge about eruption to the students was divided into three sub-sections of knowledge which were the pre-, while-, and post-disaster. These three stages required a good mastery of disaster knowledge in identifying the disaster signs, providing first aid to disaster casualties and the first thing to do to the environment after a disaster. By completing the cycle of disaster management, it was expected to make the students and society to be able to rehabilitate and reconstruct the environmental and social conditions after the disaster. The provided knowledge to ameliorate preparedness and disaster risk reduction was in line with the Sendai Framework for Disaster Risk Reduction 2015 – 2030 stating that the efforts to diminish the number of disaster victims are all activities aimed at minimizing casualties and damage to assets both with structural and non-structural disaster mitigation. The 2015-2030 frameworks emphasize the disaster risk management and instead of the disaster management. The expected outcomes are targeted disaster risk reduction, prevention of new risks, existing risks reduction and resilience strengthening (Kelman, 2015; Dickinson et al., 2016; Pearson & Pelling, 2015).

The SETS thematic learning classified as non-structural disaster mitigation aiming to equip elementary school students with disaster knowledge. It was implemented in three elementary schools in the disaster-prone areas of Mount Merapi eruption. The results showed that there were differences in the mastery of knowledge between the students taught using the SETS thematic learning integrated with local wisdom, and students who learn using another learning method. The t-test result of the pretest and posttest data on students' disaster knowledge from the control class and experimental class intended to find out whether the learning applied to the experimental class has been proven to be more effective than the conventional learning. The data analysis used the paired samples t-test comparison on SPSS version 20. The t-test data summary of the pretest and posttest on the students' ignorance from the control class and experiment class is presented in Table 2.

**Table 2.** The Summary Test-t Pre-test and Posttest Knowledge of Students in the Experimental Class and Control Class

Class	T <sub>count</sub>	df	Sig. (2-tailed)	Information
Pretest-Posttest Ex-periment Class	-80,891	37	0,000	Sig. (2-tailed)<0,05= significant
Pretest-Posttest Con-trol Class	-1,604	37	0,117	Sig. (2-tailed)>0,05= not significant

Table 2 shows that the t-test analysis of pretest and posttest data of experimental class knowledge scores obtained -80.891 with df = 37 and Sig. (2-tailed) = 0,000. Sig value. (2-tailed) was smaller than the 0.05 significance level (0.000 <0.05). The results of t-test showed that there were differences and significant increase of disaster knowledge from the experimental class before and after treatment by applying the SETS thematic learning integrated with local wisdom. Based on the t-test analysis of pretest and posttest data, the value of disaster control class knowledge obtained the t count equal to

-1,604 with df = 37 and Sig. (2-tailed) = 0.117. Sig value. (2-tailed) was greater than the significance level of 0.05 (0.117 > 0.05). Thus, the t-test results indicated no significant difference or increase in disaster knowledge of the control class.

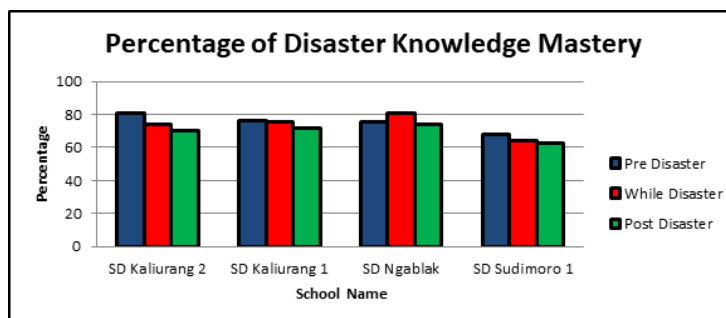
In addition to the differences, the implementation SETS thematic learning integrated with local wisdom could increase the mastery of disaster knowledge before and after learning. The increasing of the students' disaster knowledge mastery in all three elementary schools appears in Table 3.

**Table 3.** Disaster Knowledge Mastery

School Names	Pre Test	Post Test	Gain	N gain	Category
SD Negeri Kaliurang 2	51,35	72,25	20,90	0,42	Medium
SD Negeri Kaliurang 1	53,57	72,75	19,18	0,41	Medium
SD Negeri Ngablak	51,76	74,32	22,56	0,46	Medium
SD Negeri Sudimoro 1	52,32	66,25	13,93	0,29	Low

Table 3 indicates that there was an increase of the students' disaster knowledge mastery in those three primary schools (SD Kaliurang 1, SD Kaliurang 2 and SD Ngablak) which applied the thematic learning of SETS integrated with local wisdom and another primary school (SD Sudimoro 1) that adopted another method. All schools that taught disaster materials to their students either using thematic learning of SETS or other method had their students' knowledge increased. The increasing can be seen from the N-gain scores obtained by each elementary school. The highest increase occurred in the State Ele-

mentary School Ngablak with 0.46 which belonged to the medium category, the next two schools teaching disaster knowledge by implementing the thematic learning of SETS integrated local wisdom also experienced an increase in the middle level. Meanwhile, the other school which was a control school had a gain score of 0.29 which included the low category. The disaster knowledge was divided into three sub-knowledge of pre, while, and disaster. The percentage of students who mastered disaster knowledge in all three sub-knowledges of each elementary school emerges in Figure 3.



**Figure 3.** The Percentage of Students who Mastered Disaster Knowledge after Learning Activities

Figure 3 tells that the percentages of the students' disaster knowledge mastery in the three primary schools applying the SETS thematic learning integrated with local wisdom were in 'good' category, with the average percentages ranging from  $70 \geq X \leq 85$ . Of the three sub-knowledges, the highest was on the pre-disaster knowledge in Elementary School Kaliurang 2 achieving 80.50 percent. Furthermore, the highest knowledge mastery in SD Ngablak was on while-disaster knowledge achieving 80.45 percent. Also, the highest knowledge mastery of SD Kaliurang 1 was on pre-disaster knowledge which was 76,52 percent. On the other side, SD Sudimoro 1 (the control group) had the three sub-knowledges in the medium category ranging from  $55 \geq X \leq 70$ .

The difference in knowledge mastery was caused by the implementation of the SETS thematic learning integrated with local wisdom. Appropriate treatment and the provision of knowledge specifically delivered in accordance with the regions' characters and community could increase the students' understanding significantly (Andreastuti et al., 2017; Manning & Kushma, 2016; Warsini et al., 2015).

Along with the increasing of the students' disaster knowledge mastery, the SETS thematic learning could further change the students' attitudes and views toward disaster. This research also measured the students' attitudes before and after learning. The students' attitudes toward disaster in the four primary schools rise in Table 4.

**Table 4.** Improvement of the Students' Attitudes toward Merapi Eruption

School Names	Before learning	After learning	Gain	N gain	Category
SD Negeri Kaliurang 2	48,35	87,25	38,90	0,75	High
SD Negeri Kaliurang 1	52,58	88,75	36,17	0,72	High
SD Negeri Ngablak	47,86	88,32	40,46	0,77	High
SD Negeri Sudimoro 1	51,35	78,25	26,90	0,55	Medium

Table 4 shows that there was an increase on the students' attitude toward disaster in elementary school students who experienced the SETS thematic learning integrated with local wisdom, while the students in control school who were taught using different method also experienced attitude improvement but only in 'medium' category. This difference in attitude enhancement was caused by the integration of with local wisdom in the learning resulting in a more receptive student. Conceptual, real-time, and adaptable disaster knowledge was able to change the students' and community's attitudes toward disasters (Lin et al., 2017; David Strang, 2014; Gonzalez et al., 2010).

The students' attitudes toward disaster urgently need improvement as it could change the paradigm within students. All this time, the students believed that disasters are unpredictable natural events so that they have no preparation and the only thing to do is evacuating, while it is not appropriate to evacuate people without considering the region and disaster characters. Hereditarily, the students and community assume that the main signs of eruption are the emergence of white clouds from the peak of the mountain,

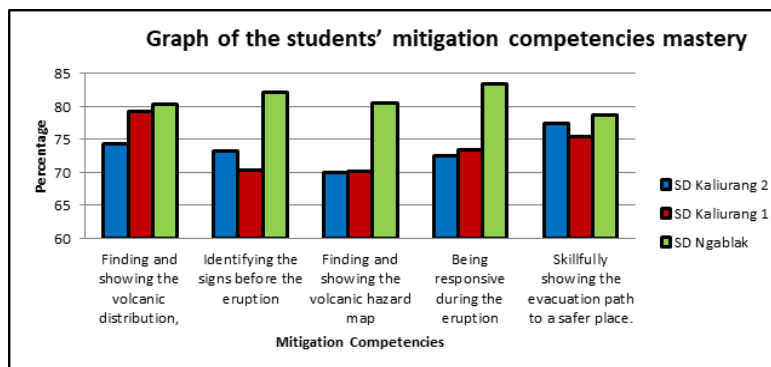
the loud voice from the inside of earth and animals' movement from the forest on the slopes of the mountain. However, animals like tigers, monkeys, lions, and deer are rarely found on the slopes of Mount Merapi recently. Thus, people could not use the old paradigms any longer. Such attitudes should be immediately changed in accordance with the conditions of the region along with technological advances. We have installed a variety of technology-based advanced equipment that serves as a sign of danger or disaster alarm. In addition, there are warnings from volcanic activity monitoring officers who always provide updated information related to volcanic activity. With this in mind, people's old attitudes have to be changed. Therefore, if there is a warning alert or there has been a warning from the volcanic activity monitoring officers to immediately move away from danger areas and flee to safer places, the people would obey it.

The improvement of students' attitudes toward disasters was influenced by both better knowledge acquisition and the SETS thematic learning implementation. The volcanic eruption simulation activities were divided into three stages: pre, while, and post-disaster simulation.

The simulation activities served to complement students' understanding of the concept of natural disasters and their mitigation efforts in real environmental conditions. The students were situated as they were facing a Merapi eruption. In these activities, students were required to be responsive and alerted to the changes in the surrounding environment before, while, and post-disaster. Therefore, these activities could improve and stabilize their disaster knowledge, improve and change their attitudes toward disasters, and develop their mastery and ability on disaster mitigation.

Disaster simulation had the main objective to enable the students to cope with the basic competencies of eruption mitigation. There were

five competencies that students need to master through disaster mitigation practices. The five competencies were 1) finding and showing the volcanic distribution, 2) identifying the signs before the eruption, 3) finding and showing the volcanic hazard map, 4) being responsive during the eruption, and 5) skillfully showing the evacuation path to a safer place. The five competencies were measured in this research by observing the students' ability in conducting activities according to the indicators. The observation results of the students' activities based on the indicators of eruption mitigation during the simulation activities appear in Figure 4.



**Figure 4.** The Percentage of Mitigation Competence Mastery

The mastery of knowledge, fast response, and mastery of disaster mitigation competencies were required in coping with the real disasters. Figure 4 shows that the mastery of disaster mitigation competencies of the volcanic eruption in three schools applying the SETS thematic learning integrated with local wisdom was in 'good' category. The schools had more than 70 percent of the students mastered all disaster mitigation indicators and belonged to good category ( $70 \geq X \leq 85$ ). This enabled the students to act quickly and responsively in real disaster situations. Better mastery of knowledge, attitudes, and mitigation competencies also resulted in a resilient and alerted community for disasters. (Amri et al., 2017).

The enhancement of disaster knowledge, attitudes, and mitigation skill of the students occurred due to the implementation of the SETS thematic learning. In the SETS thematic learning integrated with local wisdom was designed specifically to study the theme of volcanic disaster by connecting the elements of science, environment, technology, and society. These elements served to equip the students with sufficient knowledge about the natural disasters and scientific signs of

natural changes. Furthermore, the environmental elements had a role to show the students the tormented environmental conditions at any time a disaster occurs. The technology elements were given to the students to provide information about the technologies used to detect the occurrence of a disaster so as to reduce its risk. Moreover, the social elements were to educate the students on how to respond to post-, while-, and post-disaster. In addition to these four elements, this learning also integrated local wisdom as part of learning. This local wisdom was to facilitate the reconstruction of disaster knowledge among the students and community. Local wisdom acted as a bridge between the science concepts with the hereditary concepts related to disaster events. Through this learning activity, the students have gained comprehensive knowledge related to disasters and improved their disaster knowledge which they have been practicing for generations so far. In sum, the SETS thematic learning integrated with local wisdom has been proven to assist the students gained better, comprehensive and deeper knowledge about disaster especially Mount Merapi eruption.



## CONCLUSION

The implementation of SETS thematic learning integrated with local wisdom was able to reconstruct and increase the knowledge of disaster seen from the N-gain score obtained by each elementary school. The highest increase occurred in SD Ngablak which obtained a score of 0.46 and belonged to the medium category. The students' attitudes toward disaster increased in the elementary schools implementing the SETS thematic learning integrated with local wisdom, having the highest gain score of 0.77. All disaster mitigation indicators were successfully mastered by more than 70 percent of students in the good category ( $70 \geq X \leq 85$ ) in all three primary schools that adopted the thematic learning of SETS integrated with local wisdom.

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