



Disaster Hazard Map as Environmental Learning for Elementary School Students

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Abstract

All regions in the world are at risk of disaster. As part of the world, Indonesia is also an archipelagic country that is prone to disasters. One of the areas that is the focus of this research and development is the Malang area in East Java province. This area is one of the areas that recently experienced disasters in the form of volcanic eruptions, floods, and landslides in 2021-2023. The purpose of this study is to produce a geological and climatological natural disaster hazard map for learning in elementary schools. The research method used is the ADDIE research and development model which has 5 steps, namely Analysis, Design, Development, Implementation, and Evaluation. The research techniques and instruments that will be used are interviews, observation, and documentation. Data analysis in this study uses quantitative analysis with percentage techniques and qualitative analysis with a description of the product manufacturing and testing process. The results of the study showed that the geological and climatological natural disaster hazard map developed was declared valid by material experts and media experts with a percentage of 95% and 92%. After being tested in elementary schools, it received a 100% appeal rating from students. Student learning outcomes also show that 50% of students are included in the high category of learning outcomes improvement and 50% of students are in the medium category. These results indicate that the product can improve the quality of student learning.

Keywords: disaster education; environmental education; elementary school; map development; thematic map

INTRODUCTION

Based on data from the National Disaster Management Agency (BNPB) on December 31, 2021, it is known that East Java is the second position based on natural disasters that occurred in Indonesia with a total of 313 cases (Azanella, 2021). Furthermore, it was conveyed that the most common natural disasters were floods, landslides, and one volcanic eruption in Lumajang, East Java, which caused many casualties. This is also supported by the results of disaster statistics that occur in East Java which states that natural disasters that often occur include floods and landslides (BPS, 2021). The death toll has increased in 2021 compared to the previous year, one of the

factors behind this is the lack of public awareness and understanding of potential disaster vulnerabilities and mitigation efforts (Nugroho, 2018).

Previous research in India has shown that natural disasters significantly and negatively affect education especially for women, those in poverty, backward castes and minorities. There are significant implications between quality education, gender equality and climate change (Hussain & Mukhopadhyay, 2024). Children are also often victims of natural disasters, including the eruption of Mount Semeru in Indonesia, which occurred at the end of 2021, the end of 2022, and most recently the eruption of Mount Semeru on February 11, 2023 (Ma'sumah, Negara, Akbar, Maharani, & Aisyah, 2021; Nadhiroh, 2023). Based on the results of previous research, information was obtained that in December 2021 after the eruption of Mount Semeru, 86% experienced *Post Trauma Syndrome Disorder* (PTSD), 23% of which were in the severe category. The victims were dominated by women as much as 73% with the age of 25-34 years with the most victims of education being elementary school at 38% (Arifianti, 2011). Early disaster mitigation is needed in order to overcome the increasing number of natural disaster victims in East Java. One of the efforts that can be done with disaster literacy. This is also supported by the chairman of BNPB who stated that there is a need to strengthen knowledge or disaster literacy to the community, especially those who live in disaster-prone areas, for example people who live around volcanoes (Azanella, 2021; Nugroho, 2018).

Disaster risk reduction strategies require knowledge of what is dangerous, who is vulnerable and what is at risk (Lipatov et al., 2023). Good disaster management should be integrated with the field of education because education can be one of the determining factors in disaster risk reduction because it can foster community sustainability and empower students as agents of change (Arifianti, 2011; Cebrián et al., 2024). The best understanding of potential disasters should be done in primary education students with the aim of reducing the number of deaths and accidents in children under the age of 15. This is because the number of deaths of children when natural disasters occur can be said to be very high and many of them also experience stress and trauma (Nugroho, 2018). This negative impact can be minimized by providing disaster literacy in the form of geological and climatological natural disaster hazard maps in elementary schools so that people already have knowledge and awareness related to the dangers of natural disasters in the surrounding environment.

Based on previous research, Indonesia is one of the countries prone to disasters. Elementary school residents around disaster-prone areas need to be educated early on as an effort to minimize the negative impacts that may occur. One of the strategies that can be done is through conservation education that can be done to increase community knowledge and skills related to the positive and negative impacts of natural resources around them (Sayektiningsih & Meilani, 2008). This is also supported by previous researchers who said that knowledge about natural disasters and the impacts both positive and negative need to be understood by the community (Ambri & Nur Rahmi, 2022).

The purpose of this research is to produce geological and climatological natural disaster hazard maps in elementary schools. Thus, it is expected to help educate the community regarding the dangers of natural disasters in the surrounding environment. This solution also supports the role of BPBD Lumajang District to provide education related to pre-disaster prevention, mitigation, preparedness and early warning (Septianto et al., 2021; Zagarino et al., 2021).

The urgency of this research is that it is necessary to immediately make a hazard map of geological and climatological natural disasters that occur in East Java as an effort to reduce the number of casualties, both in the form of death and deep trauma, especially to elementary school-age children when natural disasters occur.

METHOD

The research method used in this study is based on the ADDIE development research design. The implementation procedure that will be carried out includes 5 steps: (1) Analysis; (2) Design; (3) Development; (4) Implementation; (5) Evaluation (Branch, 2009). The analysis stage was carried out by examining in depth the natural disasters that occurred in the Malang area of East Java province through questionnaire and documentation data collection techniques. At the design stage, the activity is to develop a framework for making geological and climatological natural disaster hazard maps based on the data that has been obtained. At the development stage, what is done is the manufacture and development of products, validation of material and media experts, product improvement. The implementation stage, what was done was a field trial on elementary school students at SDN 3 Turen Malang. The evaluation stage contains product improvement activities based on field trials.

The research techniques used in this research are (1) questionnaire; (2) interview; (3) observation; and (4) documentation. The questionnaire research technique was used to take preliminary data in the general public related to natural disasters that occurred for approximately 5 years running. In addition, the questionnaire was also used to test the validity of the product as well as user responses. The interview technique was used to extract data during the product trial. The observation technique was used to find out the implementation of the product during the trial together in the learning process. Documentation is used to determine the impact of the use of products that have been developed.

The data analysis that will be used is quantitative data analysis with percentage techniques and N-gain score calculations. Meanwhile, qualitative data analysis by describing the series of activity processes and product development results.

RESULT AND DISCUSSION

Result

The results of the research analysis or initial study are several disasters that have occurred or often occur in several areas in Malang. Several indicators were used to collect preliminary data regarding natural disasters that have occurred, and the largest disaster occurred in the Malang area. The instrument used to collect preliminary data was a questionnaire. Respondents were given a number of questions and statements, including: identity and disasters that occurred and were most memorable within 5 years.

The questionnaires were distributed from June to July 2023. This research was participated by 230 respondents from various regions. The resulting data was then analyzed and processed to provide a realistic picture of the conditions of each region in Malang. The following illustrates the results of data collection (see Table 1).

Table 1. Disaster Hazard of Region in Malang

Regional	No	District	Disaster Hazard
Malang Regency	1.	Ampelgading	-
	2.	Bantur	Earthquake
	3.	Bululawang	-
	4.	Dampit	Earthquake , Landslides, Flood, Whirlwind
	5.	Dau	Flood
	6.	Donomulyo	Earthquake , Flood, Landslides
	7.	Gedangan	Earthquake , Landslides, Flood
	8.	Gondanglegi	Earthquake
	9.	Jabung	Earthquake , Whirlwind
	10.	Kalipare	Earthquake , Flood, Landslides
	11.	Karangploso	-
	12.	Kasembon	Landslides , Flood, Volcano eruption, Whirlwind
	13.	Kepanjen	-
	14.	Kromengan	Earthquake , Landslides, Flood
	15.	Lawang	Landslides , Earthquake, Flood, Whirlwind, Fire
	16.	Ngajum	Earthquake
	17.	Ngantang	Landslides , Earthquake
	18.	Pagak	Flood , Landslides, Earthquake
	19.	Pagelaran	-
	20.	Pakis	Flood , Earthquake, Whirlwind
	21.	Pakisaji	Flood , Earthquake, Whirlwind
	22.	Poncokusumo	Earthquake , Landslides, Flood
	23.	Pujon	Landslides , Flood, Earthquake, Volcano eruption
	24.	Singosari	Earthquake , Whirlwind, Fire
	25.	Sumbermanjing Wetan	Landslides , Earthquake, Flood
	26.	Sumber Pucung	-
	27.	Tajinan	Earthquake , Whirlwind, Flood
	28.	Tirtoyudo	Earthquake , Flood, Landslides
	29.	Tumpang	Earthquake
	30.	Turen	Earthquake , Fire, Flood, Landslides,
	31.	Wagir	Landslides
	32.	Wajak	Earthquake
	33.	Wonosari	Earthquake
Malang city	34.	Blimbing	Flood
	35.	Kedungkandang	Flood , Earthquake
	36.	Klojen	-
	37.	Lowokwaru	Flood , Earthquake, Whirlwind
	38.	Sukun	Earthquake , Whirlwind, Flood
Batu	39.	Batu	-
	40.	Bumiaji	Flood
	41.	Junrejo	Earthquake

Based on the data that has been obtained, there are 5 areas that do not yet have data related to disaster threats (12%). The five sub-districts are Ampelgading, Bululawang, Karangploso, Pagelaran, Sumber Pucung, and Batu. Meanwhile, out of 41 sub-districts, there are 2 areas that can be considered safe (5%) because no disasters have occurred based on respondent data. These areas are Kepanjen and Klojen.

The results of research related to community knowledge of disaster threats in the vicinity found that around 58% of the community already knew the disaster threat and around 42% of the community did not know the disaster threat in the surrounding area. The rest also mentioned that so far the community only knows if a disaster occurs mostly comes from *Whatsapp* short

messages (54%). Design activities were carried out in the first and second weeks of August in the form of designing products from the analysis that had been carried out. In this activity, the research team created a map concept based on the results of the data that had been obtained related to disaster threats in each region. Furthermore, development activities were carried out in August. The design of the hazard map uses the help of the Arcgis 10.8 application. Activities are carried out until the product is completed in the form of a soft file.

Implementation activities were carried out in September 2023. The activity begins with product validation by material experts and media experts. Material experts are expected to be able to provide product quality decisions related to product suitability with concepts or materials. Meanwhile, media experts are expected to provide decisions related to product quality in terms of appearance and language. The material validator, gave an assessment of 95%. This shows that the product developed is appropriate regarding the material developed and in accordance with the curriculum in elementary schools. Meanwhile, the media expert validator, gave an assessment of 92%. Based on these results, it can be concluded that the products developed are in accordance with the provisions of good media and can be used in learning in elementary schools. The notes given by the validator are that an explanation is needed regarding the terms on the map so that students are not confused and add comments that basically the media products developed are good and make learning easier.

After the product is declared valid and revised in accordance with the input suggestions obtained, the follow-up is the trial at the elementary school. This activity was carried out in Grade 5 SDN 3 Turen at the end of September after revising the product validation results of material experts and media experts. The trials carried out took material on Earthquake natural disasters. Based on the results of the trials conducted at SDN 3 Turen, the implementation of activities has been carried out 100% and it indicates that the products developed are easy to implement by teachers and understood by students. Student learning outcomes before and after the application of the product along with the N-gain score are presented in table 2.

Table 2. Product Trial Results

No	Name	Pre-Test	Post Test	N-Gain Score	Criteria
1.	AKF	87	93	0.46	Medium
2.	ACT	73	93	0.74	High
3.	AFD	67	87	0.61	Medium
4.	AMQ	60	93	0.83	High
5.	ASP	80	93	0.65	Medium
6.	AFY	80	93	0.65	Medium
7.	AY	73	93	0.74	High
8.	AAI	87	100	1.00	High
9.	DAP	60	73	0.33	Medium
10.	DAA	73	93	0.74	High
11.	FSN	87	100	1.00	High
12.	FAA	60	87	0.68	Medium
13.	GAF	80	93	0.65	Medium
14.	KA	80	100	1.00	High
15.	KAR	73	93	0.74	High
16.	KNT	80	87	0.35	Medium
17.	MRP	80	87	0.35	Medium
18.	MDA	60	87	0.68	Medium

No	Name	Pre-Test	Post Test	N-Gain Score	Criteria
19.	MND	60	87	0.68	Medium
20.	NCA	80	100	1.00	High
21.	NSM	80	93	0.65	Medium
22.	NAK	60	93	0.83	High
23.	RA	60	87	0.68	Medium
24.	SVP	67	87	0.61	Medium
25.	SZN	87	100	1.00	High
26.	WFD	87	100	1.00	High
27.	ZID	67	93	0.79	High
28.	ZHF	73	93	0.74	High
	Average	73.61	92.07	0.74	High

Based on the results of the calculation, it is known that there is an increase in student learning outcomes with a high category or more than 0.7 as many as 14 students. Meanwhile, there were 14 students who fell into the category of experiencing moderate improvement. Based on the calculation of the class average, the average pre-test score was 73.61 and the post-test was 92.07 with an average N-gain score of 0.74 or included in the high category. These results indicate that an increase occurred in student learning outcomes after the use of research products in the form of disaster hazard maps, especially on the subject of Earthquake.

Meanwhile, the results of the questionnaire that has been filled out by students related to the attractiveness of the product get a percentage of 100% with several comments that the map product developed is easy to understand and understood by students, has good colors and can be developed further for other information. These results are also reinforced by interviews conducted by teachers in early October 2023 which showed that this geological and climatological natural disaster hazard map is indeed suitable to be applied in elementary schools, especially high grades because it is contained in IPAS material in grade V SD. Furthermore, it was conveyed that this product made students excited and enthusiastic in carrying out learning. Learning activities also become more effective because the media has simple packaging, is easy for elementary school students to understand, and contains disaster information data in the area around where students live so it is very relevant to be a learning media for elementary school students. The teacher also said that the advantages of the mini-style disaster hazard map are in the use of different colors in each region with the greatest threat of natural disasters and presented on one sheet so that it is more practical and easy to understand. The teacher said that there were no difficulties in using the geological and climatological natural disaster hazard map in learning because the media was easy to use and the information contained in it was clear.

In the evaluation activity, the research team evaluated the various activities that had been carried out and carried out improvements from the results of various suggestions from the results of field trials. The evaluation that has been carried out is to deepen the analysis related to the results of preliminary data on natural disasters that often occur in unfortunate areas. Furthermore, at the design stage, the evaluation carried out is the re-improvement because there is a map framework that is still not in accordance with the data obtained. at the development stage, the evaluation carried out on the improvement of geological and climatological natural disaster hazard maps, especially on adjusting the area map and various information contained in the map. Furthermore, at the implementation stage, the evaluation carried out is related to the results of validation by material and media expert validators and provides improvements to the results of validator input suggestions related to the use of terms in map information. The evaluation results

from the application of the product in the trial are that the product has been well received in elementary schools and can help make it easier for students to learn material related to disasters in the surrounding environment.

Discussion

Natural disasters can occur anywhere and at any time. The impact caused by the occurrence of natural disasters continues to increase worldwide. Therefore, mitigation is important to prepare people for disasters (Mafuko-Nyandwi et al., 2024). East Java occupies the second position regarding the occurrence of natural disasters that occur in Indonesia (Azanella, 2021). This of course has an impact on the lives of its people. The disasters that occur include floods, landslides and volcano eruptions. Based on the results of previous research, it was found that the increase in casualties due to disasters occurred due to a lack of awareness and understanding of disaster threats and mitigation efforts that must be carried out (Noor, 2014; Nugroho, 2018). This is reinforced by the research data which states that around 58% of the community in Malang already knows the threat of disasters and around 42% of the community in Malang does not know the threat of disasters in the surrounding area. This is certainly not a good number because with almost half of the community not knowing the threat of disaster, this can potentially lead to greater casualties.

Based on the results of the study, it can be seen that almost all areas of the highlands have disaster threats. There are 83% of areas indicated by disaster threats from both a geological and climatological point of view. Meanwhile, out of 41 sub-districts, there are 2 areas that can be said to be safe (5%) because no disasters have occurred based on respondent data. These areas are Kepanjen and Klojen. This is in line with previous research which shows that most areas have a disaster threat (Isnaini, 2019; Iswahyudi, 2016; Sadisun, 2004; Zagarino et al., 2021). The development of natural hazard mapping for urban scale (microzoning) is gaining popularity (Ridwan et al., 2023).

Character development affects the quality of the environment. It is necessary to cultivate character from an early age, especially in elementary school, because a healthy environment can reduce the possibility of natural and non-natural disasters. Character cultivation can be achieved through various media, such as pictures, textbooks, lesson plans, examples, and so on, which will provide provisions for the character development of the nation's next generation (Mahanani et al., 2022). This character development needs the involvement of various parties so that students not only learn about disaster threats at school, but also at home and in the community.

Based on the results of previous research shows that the most important elements of school safety and the lives of the next generation actually exist or are contained in policy documents in the form of curriculum and existing regulations. However, there is usually a gap between the documents and the reality of learning in schools (Sair, 2019; Tong et al., 2024). The results of previous studies indicate that students enjoy reading electronic media more than pocketbooks. However, the difference was not significant (Chaudhry, 2014). The results of different previous studies related to learning media, found that 2D animation learning media, games, and also museums can help socialize and educate the public regarding natural disasters in a place (Ambri & Nur Rahmi, 2022; Mafuko-Nyandwi et al., 2024). One of the media that can be

used in learning activities in order to provide reinforcement of knowledge, education and is expected to be able to shape the character of students including maps. Maps can be categorized in visual media and can help concretize abstract concepts (Arifianti, 2011; Nurseto, 2012). The Geological and Climatological Hazard Map produced by the research has been valid and has been tested in elementary schools in Malang District.

Based on the trial activities that have been carried out at the end of September 2023, the results show that teachers can carry out learning, with the results of the implementation observation of 100%. The teacher also gave positive comments regarding the developed product. The comment is that the product can help visualize the threat of disasters that occur in the environment around students so that students have more knowledge related to disasters that exist around them. Based on the calculation of student learning outcomes, it is known that students experience an increase in learning outcomes in the medium and high categories. These results indicate that the product can help improve student learning outcomes. This is corroborated by previous research which showed that participatory methods involving primary school communities in London with the issue of air pollution were effective in improving students' skills and confidence (Out et al., 2024). In addition, based on the results of questionnaires filled out by students, students gave very good scores with a percentage of 100% for product attractiveness. This also reinforces that the existence of learning media can help students learn better as the results of previous research. One of the research results revealed that there was an interaction effect of learning media and learning interest on learning outcomes related to the use of media in learning activities (Faradiba & Budiningsih, 2021; Kiromi & Fauziah, 2016; Mahanani et al., 2021; Supardi et al., 2015). Based on the activities that have been carried out and various previous studies, it can be seen that geological and climatological natural disaster map products can be used as learning media that have benefits for strengthening student competencies.

This research has a practical contribution, namely learning media can improve the quality of learning. The resulting research product adds to the innovation of learning media that can be used in elementary schools in learning related to geological and climatological natural disaster material, especially for the Malang area of East Java province - Indonesia. In addition, the results of this research also support the achievement of sustainable development goals (SDGs) 4, namely quality education. Theoretically, the results of this study add to the scientific repertoire of learning in elementary schools, especially in the social science subject family related to natural disaster material.

CONCLUSION

Conclusion

This research has limitations on the development of hazard map media for geological and climatological natural disasters in the Malang area of East Java Province, Indonesia. Another limitation is that the products developed were tested at the elementary school level. Based on the results of the research, the Hazard Map of geological and climatological natural disasters can be used as learning media in elementary schools. This product has been declared valid from material experts and media experts with a percentage of 95% from material validators and 92% from media validators. The results of product attractiveness from students obtained a score of 100%. The average N-gain score of 0.74 showed that 50% of students experienced an increase in learning

outcomes scores in the high category and 50% of students were in the medium category. Thus, geological and climatological natural disaster hazard maps can be used in elementary schools as a tool to help students learn and strengthen competencies related to disaster hazards in the surrounding environment.

Recommendation

This research can serve as a reference for future researchers, especially those researching environmental and disaster education in elementary schools. Further research related to environmental and disaster education innovation can also be conducted across countries to strengthen the quality of education.

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