Check for updates

JRCNP
OPEN ACCESS

The Effect of Virtual and Augmented Reality Technologies for Volcano Eruption Disaster Management in The Build of Environments

Nathanael Marvel Shane[1], Novita Surya Putri[2]*, **Akhmad Yanuar Fahmi[2]***

[1] Nursing Science Study Program, STIKES Banyuwangi, Indonesia
[2] Departemen of Nursing, STIKES Banyuwangi, Indonesia

Correspondence
Novita Surya Putri,
Departemen of Nursing, STIKES Banyuwangi,
Jl. Letkol Istiqlah No.109, Giri, Banyuwangi, East Java 68422, Indonesia.
email:
novita@stikesbanyuwangi.ac.id

ABSTRACT

Panjen Hamlet is located near Raung Mountain, categorized as an active volcano, and prevention activity is very common among the people of Panjen Hamlet nowadays. Volcano eruption disaster management is one of the requirements for people who live near the volcano eruption area. Due to that condition, adequate disaster management knowledge, equipment, and mental readiness are needed. This study aimed to determine the effect of Virtual & Augmented Reality Technologies (VART) on volcano eruption disaster management among Karang Taruna community adolescent members. The design of this study used a pre-experimental design with total sampling techniques. The samples in this study were 20 respondents with statistical analysis using the Wilcoxon test. The study results obtained a mean pre-test value of 2.70 with a standard deviation of 0.470, while the mean post-test value was 3.0 with a standard deviation of 0.000. The results were assigned after the data were analyzed using the Wilcoxon test in SPSS version 26. Sig = 0.014 < 0.5 were obtained, which means Virtual & Augmented Reality Technologies (VART) influenced volcano eruption disaster management. Giving VART as a new learning method plays an essential role in increasing the level of understanding in Karang Taruna community adolescent members to prepare the readiness of the respondent when faced with a volcano eruption disaster.

KEYWORDS

Volcano, Virtual Reality, Adolescent, Disaster Management

1. BACKGROUND

Knowledge of natural disasters is quite common for the public, especially for people who live in areas prone to natural disasters. Every action should be carefully thought out, such as what I should do, what objects I need to take, and where I should go. Most people may not take these three things seriously, but these three things are the basic knowledge of disaster management. One of the natural disasters that is widely highlighted is the eruption of mountains, but the incidence of this disaster may be rare compared to other natural disasters.

However, the impact of one volcanic eruption is very large and prolonged. Eruptions or volcanic eruptions can cause various disasters, not only in areas near the eruption (Setiadi, 2019).

The existence of volcanoes often invites various problems that need to be solved, both social and psychological, in the surrounding communities prone to volcanic disasters. The fall of casualties, loss of property, and the trauma of the impact of natural disasters will not subside so quickly. However, the problem is that pre-disaster activities are considered disposable workforce and budgets due to natural disasters that have not occurred yet, or activities are better directed at post-disaster infrastructure improvements where the activities are more obvious. This is important to change the mindset that ultimately changes the cultural set from disaster and post-disaster responsive efforts to pre-disaster mitigation and preparedness activities on a government scale in the regions (Faturahman, 2017).

The EM-DAT (International Disaster Database) report states that in 2018 there were reports of natural disaster events around the world resulting in the deaths of 11,804 people and more than 68 million people affected by disasters (WHO, 2018).

Based on data from CSA (Central Statistics Agency) calculated from the number of villages in Indonesia, as many as 15,754 villages have disaster mitigation components, including natural disaster early warning systems (7,968 villages), safety equipment (2,738 villages), evacuation routes (5,048 villages). Mitigation efforts in East Java, according to BPS, as many as 1971 villages that already have disaster mitigation components include natural disaster early warning systems (1,162 villages), safety equipment (346 villages), and evacuation routes (463 villages). Banyuwangi itself has 76 total villages that have implemented the three components of disaster mitigation according to BPS, including the natural disaster early warning system (21 villages), safety equipment (12 villages), and evacuation routes (43 villages). Panjen Hamlet is one of the parts of Jambewangi Village in Banyuwangi, which has implemented the mitigation disaster component like an early warning system, evacuation route, etcetera.

Knowledge results from "knowing" which happens after a person has sensed a certain object (Ratnasari, 2017). Knowledge can be a source of strength to carry out all things or desired actions; with adequate knowledge of things, we will make it easier

to make decisions. Especially in a very precarious or dangerous state, the brain will provide reflexive stimulation in response to the event. Deeds caused by reflexes can lead to good or bad things, depending on the brain's response to the results of the action. Percentages with good results can be increased through the presence of knowledge that will overcome the precarious/dangerous situation that is happening. It is also important when facing the dangers of natural disasters, namely knowledge of natural disaster mitigation. The types of natural disaster mitigation can be distinguished based on the type of disaster because the different forms of disasters will certainly have different impacts. However, sustainability can be minimized regarding psychological and physiological aspects if we have the natural disaster management experiences gained during disaster mitigation training. So the psychologic will feel calmer and less panicky, and then evacuate yourself after the situation improves.

This study's urgency is based on Mount Raung's proximity to Panjen Hamlet, which is only around 15.3 km away. If it was estimated, this location is considered very close to the source of the disaster, especially when dealing with the impact of an active volcanic eruption. The lack of preparedness of the youths in Panjen Hamlet in managing volcanic disasters has become a big concern due to the lack of activeness of the Karang Taruna Community to anticipate the occurrence of volcanic disasters in confront the eruption of Mount Raung, which is located adjacent to Panjen Hamlet. Therefore, volcano disaster management needs to be studied and empowered to overcome and minimize the impact that will occur both moments before and after the disaster. This is due to the need for more public knowledge about the importance of the form or model of management, such as how to overcome and anticipate natural disasters (Saputra et al., 2020). Thus, the importance of implementing disaster management can be realized in the community. It is necessary for outsiders who enter the residential environment of volcanic disaster-prone areas to provide teaching and training on disaster management.

2. METHODS

This study employed a quantitative with a pre-experimental design. This research uses a quantitative type of research with a pre-experimental design. This experimental research was carried out in

one group using pre-test, treatment, and post-test. This research held two tames observations.

In this study, the samples were all members of the Karang Taruna Community in Panjen Hamlet, totaling 20 people, obtained using a total sampling technique. The independent variable in this study is virtual and augmented reality technology. The instrument was used as a volcano disaster management questionnaire instrument.

Before conducting research, the researcher asked permission from the Head of the Panjen Hamlet. After approval, researchers looked for respondents to be used as samples. Then the researcher briefly explained the aim to the respondent and provided informed consent to obtain approval to participate in the research. After the respondent was willing to give consent, the researcher administered a volcano disaster management knowledge questionnaire for data collection. After the data is collected, the data is tabulated and analyzed.

IBM SPSS Statistics 26.0 for Windows was used to perform statistical analysis, with a significance level set at 5%. Using the Wilcoxon test, we examined virtual and augmented reality technologies for volcano eruption disaster management.

This study was conducted with the approval of the Research Ethics Committee of STIKes Banyuwangi. Subjects were informed that participation was voluntary; that they were not obliged to respond to items they did not want to answer; and that there would be no disadvantage or negative impact on their work due to interruption or nonparticipation. We asked the subjects to respond to the questionnaire anonymously, so that they could not be identified by their personal information or affiliation. The subjects understood that responding to the internet survey constituted consent. There were no conflicts of interest in this study.

3. RESULTS

Panjen Hamlet is a hamlet in Jambewangi Village, Banyuwangi Regency, East Java, Indonesia. The location of this hamlet is quite close to Mount Raung, about 15.4 km, so it is counted as a disaster-prone area. Disaster mitigation facilities to support safety in the event of an already available disaster include evacuation routes, directional signs, and fields. The strategic location of the field has also been implemented well, namely with an evacuation route that is easy to remember

and accessible to help the people of Panjen Hamlet.

Table 1. Respondent characteristics

Characteristics	(n)	(%)
Adolescent age criteria (Soetjiningsih, 2004)		
Early adolescence (11-13 years)	4	20%
Middle adolescence (14-16 years)	10	50%
Late adolescence (17-21 years)	6	30%
Gender		
Male	8	40%
Female	12	60%
Education Level		
Junior High School	5	25%
Senior High School	12	60%
Diploma/Bachelor	3	15%

Based on table 1 shows the characteristics of the respondents who participated in the study as many as 20. Based on adolescent age criteria less than 50% of respondents who participated in the study were middle adolescents consisting of 10 respondents (50%). Based on gender characteristics shows that more than 50% of respondents were female, with 12 respondents (60%). Based on education level, more than half of the respondents are senior high students, with 12 respondents (60%).

Volcano eruption disaster management before implementing virtual and augmented reality technology

Table 1 Distribution of respondents based on the values of volcano eruption disaster management before and after implementing virtual and augmented reality technology

Group		Mean	SD
Treatment	Pre-test	2.70	0.470
	Post-test	3.00	0.000

Based on table 2, it shows that the mean value of volcano eruption disaster management before VART was given to the group was 2.70. Meanwhile, the group's standard deviation before VART was given was 0.470. And the mean value of volcano eruption disaster management after being given VART in the group is 3.0. Meanwhile, the standard deviation after VART is given in the group is 0.000.

The Effect of VART (Virtual & Augmented Reality Technology) for Volcano Eruption Disaster Management

Table 3. Normality test results in the group

Shapiro Wilk	Pre-test	Post-test
Sig.	0,000	0,000

Table 3 shows the results of the significance normality test. A pre-test is 0.000, and the post-test is 0.000, which shows a value of < 0.05, which belongs to the abnormal data type, so to compare pre and post-values, one can use non-parametric tests with Wilcoxon tests.

The statistical test is given to prove the research hypothesis: The Effect of Virtual and Augmented Reality on Volcano Eruption Disaster Management in the Build of Environments. This study was analyzed using the Wilcoxon Test using a degree of meaningfulness α= 0.05 because the results of the data normality test were obtained before and after the intervention of abnormally distributed data with a significant value of < 0.05, and the next step was for the researcher to use the Wilcoxon Test.

Table 2 Wilcoxon Test Results

Wilcoxon Test	Post test-Pre test
Asymp. Sig. (2-tailed)	0,014

After using the statistical test obtained the value of Asymp. Sig. = 0.014, so it can be interpreted as Ha accepted because Ha hypothesis is accepted if the Asymp value. Sig. < 0.05. Therefore, Virtual and augmented Reality Technology has a significant influence on Volcano Eruption Disaster Management.

4. DISCUSSION

Volcano Eruption Disaster Management Before Implement Virtual & Augmented Reality Technology

The results showed that the mean value of volcano eruption disaster management before being given virtual and augmented reality technology was half good. Meanwhile, the standard deviation before being given virtual and augmented reality technology could be better, which

means that the respondent's level of knowledge could be more adequate overall.

A volcano or volcano is a form of heap (cones and others) on the surface of the earth built by an eruptive spice stockpile, or where melt rocks or loose magma/spices/gases originating from within the earth appear (Isnainiati, Muchammad Mustam, and Ari Subowo 2013). Factors influencing volcanic disaster management include age, gender, and education.

Based on the results of the study, it can be seen that all respondents are adolescents, both early adolescents totaling 4 respondents (20%), middle adolescents totaling 10 respondents (50%), and late adolescents totaling 6 respondents (30%). Adolescence is more likely to want always to try and figure it out. Therefore, the initial age suitable for starting training is the age of adolescence (Dhafir and Agustin 2017).

In addition to the education age, it can influence individuals in managing volcanic disasters. This study shows that various levels of education are being taken by respondents, including Junior High students, 5 respondents (25%), Senior High students, 12 respondents (60%), and Diploma/Bachelor 3 respondents (15%). This research is in line with the research of (Mashdariyah 2017), which states that when viewed in terms of development, adolescents have high potential, especially the achievement of rapid development in the ability to think and shifts regarding new societal roles. Researchers assume that education is one of the factors that can affect a person's level of knowledge. Knowledge of disaster management as early as possible greatly affects the mitigation or prevention efforts the individual will carry out in the future. So that when the teenager has reached adulthood, he can understand or understand that he has another role in society, namely awareness of disaster management.

Volcano Eruption Disaster Management After Implement Virtual & Augmented Reality Technology

The results showed that the value of mean volcano eruption disaster management after being given virtual and augmented reality technology increased by the majority. Meanwhile, the standard deviation after being given virtual and augmented reality technology has largely increased. It can be concluded that after being given the VART treatment; the respondents' experienced an increase in the mean value and standard deviation of the post-test.

The potential contained in using Virtual Reality media in education is an innovation. This innovation aims to make something new and useful in terms of time, place, and material more effective and efficient (Abdillah, Riyana, and Alinawati 2018). Research using virtual reality technology that has been carried out by (Abdillah, Riyana, and Alinawati 2018) shows that VART can significantly increase the value of knowledge with higher yields. This research proves that VART is a form of education that can increase knowledge. (Notoatmodjo 2012) said in conducting education so that health messages can be conveyed more clearly and the target community can receive the person's message clearly and precisely, media or tools are needed. These media can be in the form of print media, billboard media, and electronic media. The audiovisual method is one of the methods that can be used.

Research by Legi et al. (2019) shows that educational media using video is one of the mediums for conveying messages that are considered effective with the acceptance of the knowledge that exists in a person received through the senses. According to research, the sensory experts who channel the most knowledge to the brain are the senses of sight. Approximately 75% to 87% of human knowledge is channeled through the sense of sight, 13% through the senses, and another 12% through other senses.

In various studies, disaster management has been stated as a form of prevention. Therefore, early education will be an important factor in anticipating natural disasters. In this study, educational learning with audiovisual media of virtual reality technology provides positive feedback in encouraging increased self-awareness and knowledge. The new method of providing education through virtual reality technology is very interesting, which provides a new and fun learning nuance; there are 3D videos displayed according to the original conditions will make it easier for individuals to absorb the explanations that have been presented in virtual reality videos. The way to give this video to respondents is that each individual can try it using hardware or cell phones, and it is also accompanied by VR box tools that the researchers provided. This educational video has been designed to be as attractive as possible to not cause respondents boredom. Education with VART audiovisual media has improved volcano disaster management in adolescents.

Effect of VART (Virtual & Augmented Reality Technology) for Volcano Eruption Disaster Management

After statistical tests before and after the VART intervention, it was concluded that the "hypothesis is accepted", which means there is an influence between before and after the VART intervention.

The VR allows a simulation easily without involving various parties directly. With VR, users can feel that they are in a simulated state. They can interact with the virtual environment and simulate the countermeasures (mitigation) process. VR technology can develop interactive media to simulate an event according to a predetermined scenario (Fajriati, Roedavan, and Siradj 2021). Users can also interact directly with artificial objects and their environment, including scenarios for simulated natural disasters. So, users can practice repeatedly until they experience reality on the ground (Sukirman, Reza, and Sujalwo 2019). In line with the research of (Massi et al. 2018) states that education with video and the like (VR) method is very effective in increasing knowledge; this method is more interesting so that it helps in absorbing the information provided and is easier to obtain because respondents can look back at the education provided via the internet at any time if needed.

This study showed that the highest education level of respondents was a senior high school, with 12 respondents, or 60%, and Diploma / Bachelor, with 3 respondents, or 15%. This study found the value of the results after being given treatment to respondents with the highest high school education was 19, while in diplomas/bachelors was 20. According to (Soekidjo Notoatmodjo 2010) education is one of the basic human needs needed to develop oneself. Differences in the level of education lead to differences in basic knowledge. The higher the level of education, the easier it is for them to accept and develop knowledge and technology because someone with higher education tends to understand better and analyze new situations or atmospheres. It will be more adaptive and positive in understanding the new information provided.

5. Conclusions

Volcano eruption disaster management before implementation of Virtual & Augmented Reality Technology (VART) intervention in adolescents in Panjen Hamlet as members of the Karang Taruna Community showed that the mean value

before VART was given in the intervention group was 2.70 with a standard deviation of 0.470. Volcano eruption disaster management after implementation of Virtual & Augmented Reality Technology (VART) intervention in adolescents in Panjen Hamlet as members of the Karang Taruna Community showed that the mean value before VART was given in the intervention group was 3.0 with a standard deviation of 0.000 After using the statistical test, obtained the value of Asymp values. Sig. = 0.014. because the value of 0.014 is less than <0.05, it can be interpreted as Ha accepted because Ha hypothesis is accepted if the Asymp value. Sig. < 0.05. Therefore, it can be interpreted that Virtual and augmented Reality Technology significantly influences Volcano Eruption Disaster Management. Karang Taruna adolescent members as respondents could understand and implement Virtual & Augmented Reality Technology (VART) for Volcano Eruption Disaster Management, and spread the knowledge to their families and others.

ACKNOWLEDGMENT

AUTHOR CONTRIBUTIONS

Substantial contributions to conception, data collection, analysis, and writing: Nathanael Marvel Shane, Novita Surya Putri, Akhmad Yanuar Fahmi. Manuscript revisions: Nathanael Marvel Shane.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest concerning the research, authorship, and publication of this article.

DATA AVAILABILITY STATEMENT

The data are not publicly available due to privacy or ethical restrictions.

REFERENCES

Abdillah, F., Riyana, C., & Alinawati, M. (2018). Pengaruh Penggunaan Media Virtual Reality Terhadap Kemampuan Analisis Siswa Pada Pembelajaran Ilmu Pengetahuan Alam Kelas VII Sekolah Menengah Pertama. Edutcehnologia, 2(2), 36–38. https://core.ac.uk/outputs/289220394

Abrori, F. (2016). Gambaran Tingkat Pengetahuan Mahasiswa Keperawatan Tentang Kode Etik

Keperawatan Di Rumah Sakit Pendidikan Universitas Muhammadiyah Yogyakarta. https://etd.umy.ac.id/id/eprint/28004

Andili Ngelo, I., & Virgini Wetik, S. (2020). Pengaruh Pendidikan Kesehatan Metode Jigsaw Terhadap Tingkat Pengetahuan Konsep Diri Remaja (Vol. 9, Issue 1). http://jurnal.lib-akperngestiwaluyo.ac.id/ojs/index.php/jkanwvol82019/article/view/91/94

Boyles, B. (2017). Virtual Reality and Augmented Reality in Education. https://ieeexplore.ieee.org/abstract/document/9531005

Dhafir, F., & Agustin, S. (2017). Pengetahuan Remaja Mengenai Kesehatan Reproduksi Di Sma Negeri 1 Dolo. Jurnal Kreatif Tadulako, 17(1), 123224. https://www.neliti.com/id/publications/123224/pengetahuan-remaja-mengenai-kesehatan-reproduksi-di-sma-negeri-1-dolo

Fajriati, P., Roedavan, R., & Siradj, Y. (2021). Simulasi Penanganan Kebakaran Ringan Untuk Fakultas Ilmu Terapan Berbasis Virtual Reality. E-Proceeding of Applied Science, 7(6), 3679–3692. https://openlibrarypublications.telkomuniversity.ac.id/index.php/appliedscience/article/view/16885

Faturahman, B. M. (2017). Reformasi Administrasi dalam Manajemen Bencana. Mimbar Yustitia, 1(2), 185–201. http://e-jurnal.unisda.ac.id/index.php/mimbar/article/view/1109

Hastari, B. W., Gandasari, D., & Harry, H. (2020). Analisis Tingkat Pengetahuan Peternak Domba Dengan Menggunakan Uji T Dan Wilcoxon Di Kelompoktani Tani Maju. Jurnal Penyuluhan Pertanian, 15(1), 1–7. https://doi.org/10.51852/jpp.v15i1.428

Heryana, A. (2020). Jumlah kelompok Fungsi Syarat data. Universitas Esa Unggul, May, 1–20. https://doi.org/10.13140/RG.2.2.23266.15047

Isnainiati, N., Muchammad Mustam, & Ari Subowo. (2013). Kajian Mitigasi Bencana Erupsi Gunung Merapi Di Kecamatan Cangkringan Kabupaten Sleman. https://ejournal3.undip.ac.id/index.php/jppmr/article/view/5695

Johariyah, A., & Mariati, T. (2018). Efektivitas Penyuluhan Kesehatan Reproduksi Remaja Dengan Pemberian Modul Terhadap Perubahan Pengetahuan Remaja. Jurnal Manajemen Kesehatan Yayasan RS.Dr. Soetomo, 4(1), 38. https://doi.org/10.29241/jmk.v4i1.100

Kholifah, S., Darmawan, & Suzanti, L. (2016). Efektivitas bermain peran untuk meningkatkan keterampilan sosial anak usia dini (penelitian pra-eksperimen terhadap anak usia 4-5 tahun di kelompok a tk aisiyah bustanul athfal tirtayasa tahun ajaran 2015/2016). Infitia, 4(2). https://repository.bbg.ac.id/handle/1267

Legi, N. N., Pasambuna, M., Purba, R. B., & Kasiati, O. (2019). Media Video Makanan Terhadap Pengetahuan Dan Kepatuhan Diet Serta Pengendalian Kadar Glukosa. Gizido, 11(2), 81–87. https://ejurnal.poltekkes-manado.ac.id/index.php/gizi/article/view/768

Mashdariyah, A. (2017). Hubungan Pengetahuan Mahasiswa Tentang Manajemen Pra Bencana Dengan Sikap Kesiapsiagaan Pada Kegiatan Simulasi Bencana Banjir Di Akademi Kebidanan Mandiri Gresik Tahun 2017. Kebidanan Universitas Islam Lamongan, 66(2), 37–39. https://www.fairportlibrary.org/images/files/RenovationProject/Concept_cost_estimate_accepted_031914.pdf

Massi, G., Kallo, V., Studi, P., Keperawatan, I., Kedokteran, F., & Ratulangi, U. S. (2018). Efektifitas Pemberian Edukasi Dengan Metode Video Dan Focus Group Discussion (Fgd) Terhadap Tingkat Pengetahuan Pasien Dm Tipe 2 Di Klinikdiabetes Kimia Farma Husada Manado. Jurnal Keperawatan, 6(1), 1–6. https://ejournal.unsrat.ac.id/v3/index.php/jkp/article/view/25182

Nurma Ika Zuliyanti, N. U. L. (2019). Faktor-Faktor Yang Mempengaruhi Pengetahuan Ibu Tentang Pijat Bayi Di Bpm Sri Mulyani, Amd.Keb Desa Kaliwatubumi Kecamatan Butuh Kabupaten Purworejo. Jurnal Komunikasi Kesehatan, 10(1), 29–37. https://ejurnal.ibisa.ac.id/index.php/jkk/article/view/132

Nursalam. (2015). Metodologi Penelitian Ilmu Keperawatan : Pendekatan

Praktis. Salemba Medika. https://penerbitsalemba.com/buku/08-0249-metodologi-penelitian-ilmu-keperawatanpendekatan-praktis-e4

Nurul Aula, S. K. (2020). Peran Tokoh Agama Dalam Memutus Rantai Pandemi Covid-19 Di Media Online Indonesia. Living Islam: Journal of Islamic Discourses, 3(1), 125. https://doi.org/10.14421/lijid.v3i1.2224

Permana, S. A. (2018). Manajemen Bencana Oleh Badan Penanggulangan Bencana Daerah Kabupaten Ciamis Di Wilayah Kecamatan Sadananya Kabupaten Ciamis. Jurnal Ilmiah Ilmu Administrasi Negara, 5(3), 148–155. https://jurnal.unigal.ac.id/index.php/dinamika/article/view/1677/1354

Pujiyanti Aryani, & Trapsilowati Wiwik. (2014). Efek Pendidikan Kesehatan Dalam Upaya Penanggulangan Kejadian Luar Biasa (KLB) Leptospirosis Di Kabupaten Bantultahun 2011. http://mfi.farmasi.ugm.ac.id/files/news/5._17-2-

Purnama, S. G. (2017). Modul Manajemen Bencana. Fakultas Kedokteran Universitas Udayana, 1–89. https://simdos.unud.ac.id/uploads/file_pendidikan_dir/abbf7e649748d49cbf426b1db1b8bc01.pdf

Putra, A. W. S., & Podo, Y. (2017). Faktor-faktor yang mempengaruhi tingkat pengetahuan masyarakat dalam mitigasi bencana alam tanah longsor. Urecol 6th, 305–314. https://journal.unimma.ac.id/index.php/urecol/article/view/1549

Ratnasari, dkk. (2017). Pengetahuan Pemustaka UPT Perpustakaan Universitas Diponegoro Tentang Undang-Undang Hak Cipta. Fakultas Ilmu Budaya, 1, 1–8. https://media.neliti.com/media/publications/137572-ID-pengetahuan-pemustaka-upt-perpustakaan-u.pdf

Sadewo, M. G., Windarto, A. P., Wanto, A., Peringatan, S., Tsunami, D., Tengah, J., Timur, J., & Alam, B. (2018). Penerapan Algoritma Clustering Dalam Mengelompokkan Banyaknya Desa / Kelurahan Menurut Upaya Antisipasi / Mitigasi Bencana Alam Menurut Provinsi Dengan K-Means. 2, 311–319. https://ejurnal.stmik-

budidarma.ac.id/index.php/komik/article/view/943

Saputra, D. P., Alfaritdzi, R. M., & Kriswibowo, A. (2020). Model Manajemen Bencana Gunung Meletus Di Gunung Kelud. Public Administration Journal of Research, 2(2), 109–126. https://doi.org/10.33005/paj.v2i2.41

Setiadi, D. (2019). Bencana Alam Gunung Meletus. In BPBD kota Kediri. https://bpbd.kedirikota.go.id/view/bencana-alam-gunung-meletus

Sheilliarika, W. A., Maryani, S., & Hendi, E. (2020). Pengaruh Membatasi Mobilitas Kereta Api Guna. Jurnal Ilmiah Matematika Dan Pendidikan Matematika (JMP, 12(2), 43–48. http://jos.unsoed.ac.id/index.php/jmp/article/view/3741/2058

Sukirman, Reza, W. A., & Sujalwo. (2019). Media Interaktif Berbasis Virtual Reality untuk Simulasi Bencana Alam Gempa Bumi dalam Lingkungan Maya. 5(1), 99–107. https://journals.ums.ac.id/index.php/khif/article/view/8054

Susihono, D. W., Sri Puja Warnis Wijayanti, M. K., Dewi Purnamawati, M. K., Yusuf, D. M., Ridawati Sulaeman, S. K. N. M., Frans Judea Samosir, S.Psi., M. P., Sahrir Ramadhan, M. K., Hamdan Hariawan, M. K., dr. Baskoro Tri Laksono, S. P. M. B., & Irwan Budiana, M. K. (2020). Jurnal Keperawatan Terpadu. Jurnal Keperawatan Terpadu, 2(2), 130–140. http://www.elsevier.com/locate/scp%0Ahttp://arxiv.org/abs/1011.1669%0Ahttp://dx.doi.org/10.1088/1751-8113/44/8/085201