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Utilization of waste paper as teaching media for volcano eruption simulation in improving student knowledge

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ABSTRACT

Indonesia has the highest number of active volcanoes in the world due to its geologic location at the confluence of the Eurasian and Australian plates. However, despite this, the knowledge of local communities regarding volcanic eruptions is still very minimal. Therefore, it is important to provide education to the community in this context is the local community. This Community Service Program aims to increase community knowledge related to the process of volcanic eruption by using pulp-based learning media, so that it can become disaster mitigation knowledge. The methods used are observation, coaching or training based on practical simulations, questionnaires and interviews. The subject of this Community Service is the community of Tambun village, Baolan sub-district, Tolitoli district, totaling 21 people in collaboration with students of the elementary school teacher education program in semester III. The results of this program are the increase in community knowledge related to volcanic eruptions and the growth of community awareness related to the use of waste paper, this is in line with SDGs 4 and SDGs 17 relating to quality education and partnerships with the community.

Kata Kunci
Kertas bekas
Media pembelajaran
Gunung berapi

Pemanfaatan kertas bekas sebagai media pembelajaran simulasi letusan gunung berapi dalam meningkatkan pengetahuan siswa. Indonesia memiliki jumlah gunung berapi aktif terbanyak di dunia karena letak geologisnya yang berada di pertemuan lempeng Eurasia dan Australia. Namun meskipun demikian pengetahuan masyarakat lokal mengenai erupsi gunung berapi masih sangat minim. Oleh karena itu, pentingnya memberikan edukasi kepada masyarakat dalam konteks ini adalah masyarakat lokal. Program Pengabdian kepada Masyarakat (PkM) ini bertujuan untuk meningkatkan pengetahuan masyarakat terkait proses terjadinya erupsi gunung berapi dengan menggunakan media pembelajaran berbahan dasar bubur kertas, sehingga dapat menjadi pengetahuan mitigasi bencana. Metode yang digunakan adalah observasi, pembinaan atau pelatihan berbasis simulasi praktikum, kuesioner dan wawancara. Subjek Pengabdian Kepada Masyarakat ini adalah masyarakat kelurahan Tambun, kecamatan Baolan, kabupaten Tolitoli berjumlah 21 orang yang bekerjasama dengan mahasiswa prodi pendidikan guru sekolah dasar semester III. Hasil dari program ini adalah bertambahnya pengetahuan masyarakat terkait erupsi gunung berapi dan tumbuhnya kesadaran masyarakat terkait pemanfaatan limbah kertas, hal ini sejalan dengan SDGs 4 dan SDGs 17 yang berkaitan dengan pendidikan berkualitas dan kemitraan bersama masyarakat.

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INTRODUCTION

Indonesia is a country on the ring of fire that has many volcanoes, Indonesia has 147 volcanoes, of which 76 are still active making it the country with the highest number of active volcanoes in the world (Bhaskara, 2017). Meanwhile, according to the Ministry of Energy and Mineral Resources, Indonesia has 127 active volcanoes, 70 of which are observed by the Center for Volcanology and Geological Hazard Mitigation. Indonesia is further categorized as the country with the most explosive eruptions ever recorded and the largest number of deaths from eruptions (Cottrell, 2015).

A volcano is a mountain crater or break in the Earth's crust that is the point where liquid lava, gas, or other substances rise to the Earth's surface (Simon et al., 2020). Volcanism is a similar process that ranges several orders of magnitude in space and time, and that all kinds of geological processes occur at volcanoes (Borgia et al., 2010). Volcanic eruptions are natural events that often occur in Indonesia as one of the natural disasters (Teh & Khan, 2021). Eruptions have a negative impact in the form of damaged facilities, loss of resources, obstruction of economic activities and potentially causing many casualties (Gaire et al., 2015; Iqbal, 2021).

Another impact of volcanic eruptions is the occurrence of volcanic earthquakes and the greater impact is the occurrence of Tsunami (Barokah & Kamal, 2023; Day, 2015). The origin of the word "tsunami" is Japanese, with "Tsu" referring to "harbor" and "nami" meaning "wave". Broadly speaking, a tsunami is a wave or series of long-term ocean waves that arise due to an unmitigated disturbance in the marine environment, impacting coastal areas (Mutaqin et al., 2019). Based on the explanation, it can be seen that Indonesia has many active mountains that can trigger eruptions, volcanic earthquakes and other disasters such as tsunamis. Disaster refers to an event or series of events that pose a risk and disrupt people's lives and livelihoods. This can be caused by natural, non-natural factors, or human actions that result in human losses, environmental damage, loss of property, and psychological effects (Kurniawati, 2020; Megananda et al., 2023).

This service activity the team focuses more on volcanic disasters using three-dimensional paper mountain teaching media, because volcanic eruptions do not occur in all parts of Indonesia, unlike floods which almost all regions have been affected, with this causing many people who do not know the process of eruption (Bakkour et al., 2015; Ilham & Amal, 2023).

Indonesian people in general do not know the process of volcanic eruption, especially those who live in non-volcano areas, therefore it is necessary to illustrate the process of volcanic eruption either in the form of a documentary video, or animation (Kerlow et al., 2020; Lansigu et al., 2014; Nadila et al., 2023; Rapprich et al., 2017). This community service activity is carried out with simulations using three-dimensional teaching media which of course can be demonstrated directly by participants so that participants can directly observe the eruption process from the simulation. In contrast to using video illustrations that use two-dimensional media, participants can only see the process without direct demonstration.

The team prefers to use the simulation practice method, this activity in addition to facilitating participants' understanding of the eruption process is also an effort to reduce paper waste. According to data from KLHK in 2020, the amount of paper and cardboard waste is around 21.86 grams per square meter, therefore to minimize the increase in paper waste, it can utilize paper waste into media in learning. Waste paper can be turned into useful items with added value. For example, turning it into pulp that is used as teaching media (Basyari et al., 2022; Hamna & BK, 2023; Khoeriyah & Kamal, 2023). The utilization of learning media using paper waste not only improves the quality of learning, but the utilization of paper waste can increase environmental awareness.

The team conducted the service by using learning media because learning media can support student learning motivation (Kang & Ritzhaupt, 2021; Maruti et al., 2023). One of the tasks of an educator is to motivate students as expressed by KI Hajar Dewantara "Ing Madya Mangun Karsa" which means, as a leader (educator) who is in the middle, the ability to inspire, motivate, collaborate, and encourage creativity in students is important. This strategy can be realized through the application of the discussion method where the teacher acts as a source of ideas and a guide who provides guidance and input to students (Alika et al., 2023; Mudana, 2019).

This community service is also carried out based on the basic law article 31 paragraph 1 which means that the community or citizens have the right to education. In the research location, there are many people who have not received upper secondary education so they do not have much knowledge related to volcanic eruptions. The importance of disaster knowledge is important so that this service is carried out.

This community service program also has relevance to several Sustainable Development Goals (SDGs), especially SDG 4 (Quality Education) and SDG 11 (Sustainable Cities and Settlements). (1) SDG 4 - Quality Education: This community service directly contributes to increasing community knowledge about the process of volcanic eruptions. By educating the local community, this program supports the achievement of SDG 4 which emphasizes the importance of quality and inclusive education. (2) SDG 11 - Sustainable Cities and Settlements: Education on volcanic eruptions has a positive impact on people's awareness of the risks of natural disasters in their area. This can help create more disaster-resilient communities. By encouraging the community to utilize waste paper into three-dimensional learning media, the program also creates awareness on the importance of waste management and contributes to sustainable urban development. (3)

SDG 13 - Action on Climate Change: Although not directly, this program can also relate to SDG 13 by raising awareness of natural phenomena such as volcanic eruptions, which can contribute to the understanding of climate change and its impacts. (4) SDG 17 - Partnerships to Achieve Goals: The collaboration between students and local communities in this program creates partnerships that are in line with SDG 17. These partnerships support the achievement of sustainable development goals through participatory and inclusive approaches. Through this community service program, there are concrete efforts to increase community knowledge about natural disasters, create environmental awareness, and support sustainable development in accordance with the principles of the SDGs.

The community service also uses simulation teaching media made of paper pulp as an effort to reduce paper waste in the surrounding environment. The teaching media can be used several times or the media is durable, so there is no need to throw it away after use because it can be reused. The advantages of the media that the team uses are that the material is easy to find because it comes from paper waste (non-synthetic), easily decomposes when disposed of so it does not pollute the environment, supports recycling programs, the materials used in the eruption experiment process are not dangerous. The making of this learning media also supports Article 11 paragraph 2 of Government Regulation No. 81 of 2012 which requires every individual to reduce and handle waste problems. From this regulation, the team uses paper waste to support waste reduction, in this case paper waste.

Based on the description above, the team conducted community service to the local community around the campus who had absolutely no knowledge related to volcanic eruptions and worked together. This community service activity also involves third semester students to help improve the understanding and knowledge of the community regarding the process of volcanic eruptions. The team used waste paper as a base material in the process of making the mountain as an effort to utilize and reduce paper waste.

METHOD

The target in this service is the local community who live in Tambun Village, Baolan District, Tolitoli Regency in Universitas Madako Tolitoli. This service also involves students of the Elementary School Teacher Education Study Program, Semester III Class C, totaling 21 students. The reason for this service is to increase the knowledge and understanding of the local community regarding volcanic eruptions, because many local people do not know the process of volcanic eruptions and have never directly seen the volcanic eruption, therefore simulation activities are needed using the help of three-dimensional teaching media.

The method of implementing the service was carried out with initial observations, volcanic eruption simulations, questionnaires and participant response interviews. Initial observations are made to understand the context and initial conditions of the participants (community) or the area that is the focus of the service. This helps gain a better understanding of the problems faced. In this case, the problem encountered is the lack of community understanding related to volcanic eruptions. Operationalization of observations is carried out when the service team visits the location or subject of focus and will observe the condition of community and environmental knowledge directly and record any field facts observed during the observation.

At first the team observed the participants, then continued with the process of making teaching media made from papier-mâché and lava made from a mixture of baking soda, liquid soap and vinegar, then the team simulated a volcanic eruption using the teaching media that had been made. The simulation was carried out by demonstrating three types of mountains, including mountains that are active, mountains that are inactive, and mountains that are no longer active. This community service activity ended with interviews with participants to determine the level of satisfaction and provide space for participants to provide criticism and suggestions to the service team.

The volcanic eruption simulation was conducted to test the response and readiness of participants in dealing with emergency situations that might occur. Simulations were also conducted to help participants understand the process of volcanic eruption with the help of three-dimensional volcano learning media. The simulation was carried out with the initial stage of presenting material related to volcanic eruptions and the geographical conditions of Indonesia which has many volcanoes so it is important to know it as an effort to disaster mitigation preparedness, the next stage is to demonstrate the process of volcanic eruption using volcano teaching media mixed with vinegar and baking soda so as to trigger a reaction and cause gas to push it out, this is likened to lava coming out of the mouth of a volcano. The simulation process is expected to increase the knowledge and experience of participants (community) because participants are directly involved in simulation activities by observing what the process of volcanic eruption is like, which is likened to mountain media and a mixture of baking soda and vinegar as lava.

The use of questionnaires conducted online through the Google Forms platform as an efficient evaluation material because the answers to the questionnaire go directly to the service team server. The questionnaire was given after a series of observation activities and simulation-based training had been completed. The questionnaire presented contains indicators including: (1) Participant satisfaction regarding the material and training provided, (2) The durability of the teaching media used, (3) Community service contribution in increasing community knowledge and reducing paper waste,

(4) The use of teaching media can be used at other educational levels. It is expected that this questionnaire can measure participant satisfaction related to the community service program that has been carried out.

Interviews were conducted to measure in-depth understanding of participants' views, experiences, and expectations related to the problems faced. The interview was operationalized by interviewing a small number of randomly selected participants with questions containing their understanding of the eruption process and the geographical conditions of Indonesia. The interviews were expected to reveal qualitative aspects that may not be covered in the questionnaire, provide better context, and help detail the needs and solutions desired by the participants.

To measure the success of this service program, analytical techniques that can be used include (1) *Initial Observation Analysis:* Evaluate the results of initial observations of participants to assess the level of participation, engagement, and initial reactions to the program; (2) *Volcano Eruption Simulation Analysis*: Assess the effectiveness of the volcano eruption simulation in conveying information and building participants' understanding of the natural phenomenon; (3) *Questionnaire Analysis:* Using data from the questionnaire to evaluate the knowledge gained by participants, their level of satisfaction with the program, as well as feedback for improvement; (4) Analysis of Participant Response Interviews: Analyzing the results of the interviews to get an in-depth view of the participants' level of satisfaction, their understanding of the material, and suggestions and criticisms that can be used for future improvements.Using a combination of these analysis techniques, a comprehensive understanding of the success of this service program can be generated as well as areas for improvement in the future.

Figure 1. Stages of community service implementation

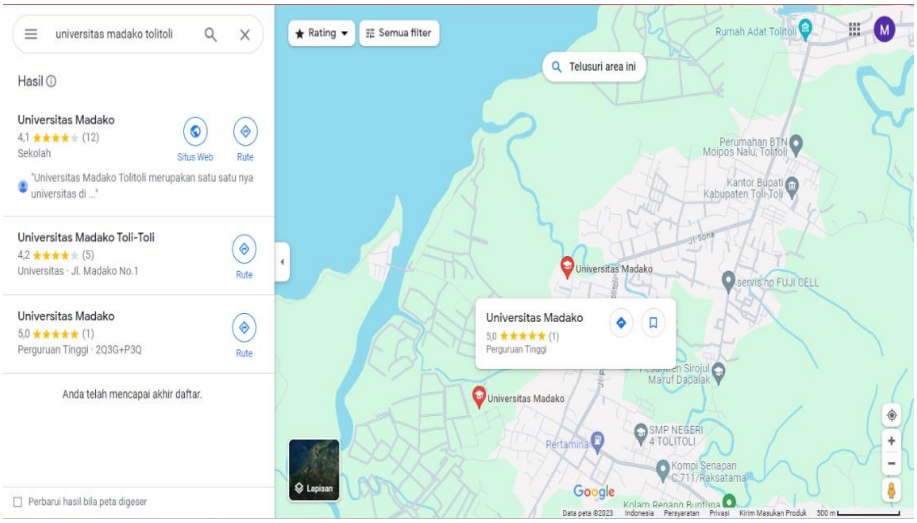

Figure 2. Location map of community service activities

RESULTS AND DISCUSSION

Learning media is a tool that helps in the process of teaching and learning with the aim of explaining the message that wants to be expressed when learning takes place. This enables the achievement of learning objectives in a more effective and efficient way (Alika et al., 2023; Amalia et al., 2023; Setiawan et al., 2021). In this case, the team used three-dimensional visual learning media made from papier-mâché. The team made three mountains with two different shapes and three different types of activities. The shape of the mountain made is a strato volcano and the maar volcano has a variety of activities such as consisting of active volcanoes, non-active volcanoes, and dead volcanoes (Zulfa et al., 2023; Trisiana et al., 2023; Simon et al., 2020).

The volcano teaching media simulation process activity is presented in Figure 3. Figure 4 presents documentation of community service participants. Meanwhile, Figure 5 shows a simulation of active strato volcano, smoking maar volcano and dead maar volcano (inactive).

Figure 3. Volcano teaching media simulation process

Figure 4. Documentation of community service participants

Figure 5. Simulation of active strato volcano, smoking maar volcano and dead maar volcano (inactive)

Initially when the team held deliberations to discuss the preparation of this service, the team planned to use clay and rice ash as the basic ingredients for making volcano teaching media. However, during the first stage of the initial making, the team experienced problems because the basic ingredients of clay were difficult to obtain in large quantities, and the team also experienced problems during the process of making and drying the teaching media, because during the drying process, the mountain teaching media was damaged in the form of cracks which were quite severe. Therefore, in the second stage of making the team overhauled or remade the mountain which would be coated with cement plaster, but this did not work because the mountain had cracks and the team had difficulty when lifting the media due to excessive weight.

The team took the initiative to change the base material from clay to paper pulp. In making phase III, the team re-made three mountain teaching media with pulp base material which was processed by soaking for approximately three hours. The materials and equipment used in making volcano teaching media, as in the following table.

Table 1. Materials and equipment

No.	Material	No.	Equipment
1.	Paper	1.	Chainsaw
2.	Adhesive or Wood Glue (18 pcs)	2.	Scissors
3.	Triplex/Plywood	3.	Measuring meter
4.	Gray Color Paint	4.	Pencil
5.	Baking Soda (2 pcs)	5.	6 Piece Bottles
6.	2 Bottles of Vinegar	6.	Thin Fabric
7.	Food Dyes		
8.	Liquid Soap		
9.	Used Cardboard		

In stage IV, the team conducted Community Service, the subject of service was the local community who lived in Tambun Village around Universitas Madako Tolitoli with a total of 21 participants, besides that this community service also involved active third semester students of the PGSD Study Program. In this community service program, first the process of making volcano media is carried out by utilizing the materials and equipment that have been prepared, then the design process is carried out in stages: (1) Cut the paper into small pieces; (2) Soak the paper for about three hours, (3) The paper is cut into as small pieces as possible and moistened to form pulp; (4) Squeeze the paper using cheesecloth to reduce moisture content; (5) Mix the paper with glue until evenly distributed; (6) Shape the pulp on plywood to resemble a mountain then place 3 bottles in the middle of the mountain as a support; and (7) Dry the mountain teaching media for about two days, after drying, give color as needed.

After the design of the volcano media was completed, three types of volcanoes were simulated based on their level of activity, namely active volcanoes, inactive volcanoes, and dead volcanoes. In the initial simulation, the team simulated active volcano teaching media (eruption). The volcanic eruption was carried out by mixing the compound CH3COOH (Vinegar) with NaHCO3 (Baking soda) to produce a lava-like reaction due to the reaction between vinegar (acetic acid) and baking soda (sodium bicarbonate) producing sodium acetate, water, and carbon dioxide gas. When the two ingredients react, there is a release of gas in the form of bubbles. This gas is carbon dioxide that results from the chemical reaction, resembling the rise of mountain lava to the earth's surface (Musa & Kamal, 2022; Purwasih & Sahnan, 2022; Supriatin & Hayati, 2022)

The mountain shape used in this simulation is a strato-volcano shape. Strato or composite conical volcanoes are the most common and riskiest shape compared to other types of volcanoes (Galindo et al., 2021; Idris et al., 2022; Muttaqien & Awiria, 2022). The lower part tends to be flat, but the higher up it gets steeper to form a conical structure. The tops of strato volcanoes usually have small craters. They generally form in zones where plates meet each other (subduction) or areas of convergence, although their shapes are not always the same as they are affected by the variety and type of eruptions.

In the simulation, the team explained the causes of volcanic eruptions. The main cause of volcanic eruptions is the tectonic activity that occurs in the Earth's plates (Alfina et al., 2022; Masum & Ali Akbar, 2019; Wulandari et al., 2022). When two plates meet or slide over each other, the pressure and friction between them can cause cracks and fissures in the Earth's crust. Apart from tectonic activity, mountains can also erupt due to volcanic activity. As magma rises from the deep layers of the earth towards the surface, the resulting pressure and heat can cause volcanoes to erupt. Other factors that can affect a volcanic eruption include the gas content in the magma, the state of the crater, and weather conditions (Fitri et al., 2023; Popa et al., 2021).

The gas content in magma can also affect mountain eruptions. When magma rises to the surface, the pressure of the gases inside may increase (Mittal & Richards, 2019; Stibies et al., 2023). If the pressure of these gases cannot be released properly, the mountain will experience a violent eruption as a result. Gases that are usually present in magma include water vapor and carbon dioxide as well as sulfur dioxide, and nitrogen. The state of the mountain crater can also affect the eruption of the mountain. If a mountain crater is sealed, the pressure of magma rising to the surface will accumulate inside the crater, this accumulation of pressure will cause a strong eruption when the crater finally breaks (Bato et al., 2021; Sobon et al., 2023; Wattimena et al., 2022).

The second simulation, the team simulated a resting mountain, which is a mountain that only emits smoke without emitting lava. The simulation was carried out by using used cardboard boxes that were burned as smoke-producing materials that were inserted into the mountain hole. The shape of the mountain used in this simulation is the shape of a maar mountain. Maar is a depression or basin that often contains water, with a diameter of up to 2 kilometers, and is surrounded by deposits from volcanic eruptions. Maars that have depressed craters without water are referred to as "dry

maars" (Agustin & Bronto, 2019; Astari, 2022). A maar is a basin surrounded by sediment formed by a volcanic eruption (Ampry et al., 2022; Simon et al., 2020). While in terms of language, maar is a term derived from German which means "crater" or "crater". The main reason why volcanoes only emit smoke without emitting lava is because of the formation of a lava dome in the belly of the volcano (Adu & Cendana, 2022; Christian et al., 2020). This lava dome is formed when molten magma cools and solidifies in a magma channel (Tang et al., 2022). As a result, the pressure inside the volcano increases and traps gas and water vapor inside.

In addition, the geological conditions surrounding the volcano can also affect its activity. If there are fissures or cracks around the volcano, the magma pressure will be reduced and cause the volcano's activity to become quieter. However, even if it only emits smoke, a volcano can still harm the surrounding environment. The smoke emitted by volcanoes can contain toxic gases such as carbon monoxide and sulfur dioxide that can harm human and animal health.

The dead mountain teaching media is not simulated, it is only given an explanation related to the phenomenon that causes the mountain to have an inactive or dead status. Dead mountains are also referred to as dead mountains (Al-Maraghi et al., 2017). A volcano becomes dormant or dead when there is no more volcanic activity occurring within it. This can be caused by a variety of factors, including changes in the magma source, the closure of magma conduits, or the cooling of magma below the surface. When a volcano is dormant, it means that there are no signs of eruption or volcanic activity for a significant period of time. However, dormant volcanoes have the possibility of becoming active again although the likelihood is relatively low (Poland & Anderson, 2020).

Changes in the magma system or pressure building below the surface can trigger volcanic activity again. In some cases, dead volcanoes can undergo a process of "reactivation" where volcanic activity returns after a long period of inactivity. While this is not common, there have been instances where long-dormant volcanoes have erupted again. However, it is important to remember that when a dormant volcano reactivates, it can pose a serious threat to the surrounding environment. Therefore, constant monitoring of dormant volcanoes is essential to mitigate risks and anticipate possible eruptions.

After the volcano eruption simulation was carried out, the service team gave an online questionnaire to 16 participants who were willing to fill out the questionnaire with the aim of measuring how well the volcano simulation process was carried out by the community service team.

. The questionnaire presented contains indicators including: (1) Participant satisfaction related to the material and training provided, (2) The durability of the teaching media used, (3) Community service contribution in increasing community knowledge and reducing paper waste, (4) The use of teaching media can be used at other educational levels. It is hoped that this questionnaire can measure participant satisfaction related to community service that has been carried out. Meanwhile, to measure the participants' cognition, it was measured by an evaluation interview.

The questions and the percentage of answers to the questionnaire or questionnaire given to community service participants include: (1) How satisfied are you with the community service project that the team did? Participants' answers: 75% very satisfied and 25% satisfied. (2) How did the research team perform in explaining the materials and simulations? Participants' answers: 81.3% very satisfied and 18.8% satisfied. (3) How good is the mountain project that the community service team made? Participants' answers: 37.5% very satisfied and 62.5% satisfied. (4) Do you think this project can be applied to elementary school students? Participants' answers: 68.8% answered yes and 31.3% answered no. (5) How durable is the mountain project that the community service team made? Participants' answers: 62.5% durable and 37.5% not durable enough. (6) Can this project be used for socialization purposes to the community? Participants' answers: 93.8% answered yes and 6.3% answered no. (7) Can this project reduce paper waste? Participants' answers: 93.8% answered yes and 6.3% answered no.

From the results of the questionnaire above, it can be concluded that the majority of community service participants are satisfied with the material provided by the community service team with a satisfaction presentation in the range of 75-80%, the use of media is also durable according to the views of participants through questionnaire answers, and this project can be applied to other levels such as elementary schools and can reduce the use of waste. This is in line with SDGs 4 Quality education because it involves collaboration between students and the local community and SDGs 11 Sustainable cities and settlements by reducing paper waste which is abundant in the service area.

After providing a link to the online questionnaire, the research team also conducted interviews with four community service participants consisting of 2 male participants and 2 female participants, the results of the interviews are presented in tabular form. A knowledge evaluation interview is an interactive process in which an interviewer asks a specific individual or subject to measure, assess, or evaluate his or her understanding and knowledge of a topic or field specific topic. The purpose of a knowledge evaluation interview is to understand the extent of information, concepts, or knowledge possessed by the subject regarding the topic being evaluated. In addition, another goal is to identify knowledge weaknesses, additional educational needs, or areas where the subject requires further assistance to improve their understanding of the subject.

1. What is a volcano? Participants' answers are presented in Table 2.

Table 2. Questions and answers of community service participants

Respondent's Initials	Group	Answers	Answer Result Description
MA	I	A volcano is a mountain that erupts and can emit lava.	Very good
MA	I	A volcano is a mountain filled with magma that can eject lava.	Very good
PA	I	A volcano is a mountain that has a volcanic crater filled with magma.	Very good
M	I	Volcanoes are mountains that contain magma deposits that can emit lava.	Very good

2. What is the process of a volcanic eruption? Participants' answers are presented in Table 3.

Table 3. Questions and answers of community service participants

Respondent's Initials	Group	Answers	Answer Result Description
MA	I	Volcanic eruptions occur due to magma deposits in the bowels of the earth, pushed out by high-pressure gas.	Good
MA	I	The eruption is caused by the shifting of the earth's structural layer, which triggers the gas pressure that pushes the magma out.	Very good
PA	I	The occurrence of eruptions is triggered by the pressure of gas that pushes magma deposits, now these magma deposits come out due to the push of high-pressure gas, caused by the collision of two plates.	Very good
M	I	Eruptions occur due to the collision of the earth's plates, which causes great pressure, so that the magma liquid is pushed and moves up and into the crater channel and out.	Very good

3. Why does Indonesia have many volcanoes? Participants' answers are presented in Table 4.

Table 4. Questions and answers of community service participants

Respondent's Initials	Group	Answers	Answer Result Description
MA	I	Because Indonesia is a ring of fire country, there are many volcanoes in Indonesia.	Very good
MA	I	Indonesia has many volcanoes due to its location on the Pacific Ring of Fire, an area along the edge of the Pacific Ocean that is prone to tectonic activity, making it susceptible to volcanic formation and activity.	Very good
PA	I	Indonesia is located on the "Pacific Ring of Fire," a region along the edge of the Pacific Ocean that experiences frequent seismic and volcanic activity. This is due to its geographical location at the confluence of the Indo-Australian, Eurasian and Pacific tectonic plates. As a result, there are many subduction zones, plate boundaries, and tectonic spreading zones that trigger volcanic activity in Indonesia, making it home to many volcanoes.	Very good
M	I	I think Indonesia has many volcanoes because the country is located in a region that experiences frequent earthquakes and volcanic activity. As I learnt, Indonesia is located along the Pacific Ring of Fire, a place where tectonic plates meet and a lot of volcanic activity occurs. This is related to Indonesia's geographical location at the confluence of several major plates, such as the Indo-Australian, Eurasian and Pacific plates. As a result, there are many subduction zones and tectonic spreading zones that can trigger volcanic eruptions in Indonesia.	Very good

From the Table 2, Table 3, and Table 4, it can be concluded that participants can answer questions properly and correctly, this proves an increase in the knowledge of participants from before who did not know the volcano simulation at all. The increase in knowledge is due to the provision of material accompanied by teaching media simulations that directly involve community service participants so that they can feel and understand the phenomena that occur in simulations and actual conditions. This is in line with previous research which states that the simulation method can increase community understanding and knowledge (Nurbaya et al., 2022).

CONCLUSION

In accordance with the findings that have been reviewed, it can be concluded: (1) This volcanic eruption simulation can improve the science literacy knowledge of Primary School Teacher Education students in the third semester of Universitas Madako Tolitoli, because participants can better understand the process of volcanic eruption because participants are directly involved in the simulation; (2) After going through the volcanic eruption simulation, students managed to describe and understand the process of mountain eruption, recognise volcanoes in Indonesia, and understand the chemical reaction between vinegar and baking soda; and (3) Primary School Teacher Education students in the third semester of Universitas Madako Tolitoli showed high enthusiasm and enthusiasm during the implementation of this volcanic eruption simulation and increased awareness of the importance of utilising paper waste. Based on what has been discussed, the service team provides suggestions: (1) In future research, it is recommended to adopt broader quantitative methods as well as case studies covering various geographical contexts in order to expand the generalisation and application of the use of paper waste in volcanic eruption simulations; (2) Propose further collaboration between educational institutions, the paper industry, and environmental scientists to develop practical guidelines for the use of paper waste in volcanic eruption learning as an effort to support environmental sustainability; (3) To complement the results of this study, further research involving a survey of student responses to the use of paper waste as a teaching medium for volcanic eruption simulation is expected to gain a more comprehensive insight into its acceptance and benefits; (4) Further consideration is needed regarding the adaptation of this model in the context of distance learning (online) to ensure its accessibility for students in various locations as well as the application of supporting information technology; and (5) Encourage further discussion on the potential integration of paper waste in the formal education curriculum to expand students' understanding of natural disaster mitigation, especially volcanic eruptions, as an important part of environmental and disaster understanding.

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