Developing GeoWeb Semeru Based on Progressive Web App to Improve Disaster Awareness of Elementary School Students in Semeru Volcano Area

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Abstract. Disaster awareness is important to be instilled in elementary school children to reduce disaster risk. In the education process at school, the used of media that is by the student characteristics to support disaster education still needs to be improved. This research aims to develop GeoWeb Semeru based on progressive web app that is feasible and effective in increasing disaster awareness of elementary school students around Mount Semeru. The meth-od used research and development with the ADDIE model steps. The ADDIE model consists of five systematic stages: analysis, design, development, im-plementation, and evaluation. Before implementation, GeoWeb Semeru was validated by media and material expert validators to obtain media feasibility. The effectiveness of the media was tested through experimental research us-ing one group pretest-posttest design. The research subjects were 36 fifth-grade students of SDN Sumberwuluh 2. The research location was chosen because it is an elementary school that was directly affected by the eruption of Mount Semeru in 2021. Data collection using interviews, questionnaires, and tests with the analysis used is quantitative descriptive. The media effec-tiveness test using the Mann-Whitney obtained a value $0.000 < 0.05$, indi-cating that GeoWeb Semeru effectively increases students' disaster aware-ness. GeoWeb Semeru is an innovative media in disaster education, especial-ly in increasing students' disaster awareness in the Semeru Volcano area.

Keywords: Disaster awareness, geoweb semeru, progressive web app

1 Introduction

Indonesia is one of the archipelagic countries that has a high level of vulnerability to natural disasters, especially volcanic eruptions, because Indonesia is located at the confluence of 3 tectonic plates [1], [2]. The three tectonic plates include the Indo-Australian plate, Eurasian plate, and Pacific plate [3]. The Indonesian region is also passed by two of the world's active mountain ranges, namely the Mediterranean Circumpolar

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and the Pacific Circumpolar, which causes many volcanoes located in Sumatra, Java, and Nusa Tenggara. One of the mountains that often erupts is Mount Semeru.

Mount Semeru is one of the world's most active volcanoes located in Lumajang Regency, East Java, Indonesia. Its beauty and potential as a natural tourist attraction have attracted many visitors each year. However, behind its beauty, Mount Semeru also carries significant potential disaster risks for the surrounding communities [4]. Volcanic eruptions, lava flows, rockfalls and other hazards can seriously impact the safety and lives of local communities [5], [6]. Mount Semeru was recorded to have erupted in December 2021 and 2022, which caused 10,395 residents to flee to several evacuation points. The eruption of Mount Semeru also caused 51 deaths, damage to houses, loss of property, and damage to public facilities and the silver bridge as one of the accesses to Lumajang Regency. The eruption also had an impact on the implementation of education, as several schools were damaged. In the face of this disaster threat, it is important for the community around Mount Semeru, especially students, to have a high awareness of the potential hazards and preventive measures to be taken [7], [8].

Education is an important sector and one of the means to reduce disaster risk through disaster education. Disaster education implemented in schools plays an important role in increasing students' awareness of the disaster risks around them and can encourage preparedness actions [9], [10]. Students who live in disaster-prone areas really need to get disaster education [11], [12]. Because elementary school-age children do not understand the actions that must be taken when a disaster comes [13]. The existence of disaster education in schools encourages students to recognize potential disasters in the surrounding environment, anticipatory actions through capacity building and understanding the signs of a disaster, as well as ways to save themselves to reduce disaster risk [14], [15]. In addition, disaster education at school is also considered very effective for increasing disaster awareness and students can provide and disseminate knowledge about the disaster to their families [16], [17]. However, in reality, in the learning process, teachers have not been able to integrate disaster education in the curriculum and lack of skills in developing learning media that are suitable for student characteristics as a way to facilitate the delivery of material [18].

Education in the current technological era refers to changes in learning approaches that are carried out by utilizing the latest technology. So that it is necessary to make changes in the curriculum, methods, and technology-based learning media [19]. The rapid development of technology provides opportunities for teachers and students to utilize technology in learning [20]. The use of technology allows teachers to design learning methods or media that suit students' needs, as well as offer more interactive and efficient learning experience [21]. Through the use of technology in learning, students can easily access materials flexibly anytime and anywhere [22]. The utilization of technology in learning can also increase student participation and facilitate collaboration between students and teachers so that it can help in developing knowledge and skills effectively.

Geoweb Semeru is one of the media that combines geographic information with modern web technology. By utilizing relevant geographic data, this technology can provide a better understanding of the area around Mount Semeru and the threats of disasters that may occur [23]. Meanwhile, a progressive web app is a web application that

provides an experience similar to a native application, but can be accessed through a web browser without the need to download or install additional applications [24], [25]. By combining these two concepts, the PWA-based GeoWeb Semeru can be a strong solution in increasing community disaster awareness, especially for students around Mount Semeru. Through the development of GeoWeb Semeru, students gain easy and real-time access to information about potential disasters and precautions that must be taken [26]. Students can see a map of the area around the mountain clearly and obtain important information about emergency shelter locations and evacuation routes. Thus, students will be able to take appropriate actions in emergencies and reduce risks to their safety and lives.

Research on disaster education using web-based learning media stated in [27], provides a positive result. One of the advantages of using web-based learning media in disaster learning is the development of students' cognitive abilities [28]. The use of technology in learning makes it easier for students to understand disaster material through the visualizations presented and gain new learning experiences [29]. In addition, disaster learning using web-based learning media can increase student interest and participation, thus creating active and enjoyable learning. These results are in line with previous research, which states that web-based learning media has a positive impact on students, especially in increasing knowledge about disasters [30]. However, research on the development of web-based learning media on disaster learning is only carried out at the junior high school to high school level, not in elementary schools.

Based on observations made at elementary schools affected by the eruption of Mount Semeru, namely SDN Sumberwuluh 2, it was found that the level of student disaster awareness in dealing with volcanic eruptions was still low, as evidenced by the lack of student knowledge related to the symptoms or characteristics of volcanoes that will erupt, as well as evacuation steps that must be taken when a disaster occurs. This is because the teacher in delivering the material has not used disaster learning media that is less interesting and tends only to use the lecture method. This cause the students knowledge is limited to the impact of disasters and have not been able to apply what should be done to reduce the risk of existing disasters. Based on the needs analysis, it is known that students are more interested in learning by audiovisual support by pictures and videos. So it is necessary to develop GeoWeb Semeru based on progressive web app that contains disaster material about Mount Semeru equipped with pictures and videos that can increase students' disaster awareness.

Based on this description, the researcher developed GeoWeb Semeru based on progressive web app that aims to provide literacy related to disaster risk awareness for elementary school students in the Lumajang district. GeoWeb Semeru based on progressive web app can help students' understanding and awareness level of disasters in the surrounding environment. The development was carried out by identifying the disaster mitigation habits of local communities and analyzing the science values contained therein [31]. The development of GeoWeb Semeru based on progressive web app is an innovative solution for increasing students' awareness knowledge in elementary schools.

2 Method

This research used the Research and Development (R&D) method with the ADDIE model development stages. The ADDIE model consisted of 5 stages in a programmatic and systematic manner [32], [33]. The selection of this model was based on the fact that the ADDIE model was systematic and in accordance with the theoretical basis of learning design [34]. The procedures of the ADDIE development model are shown in Table 1.

Table 1. Development procedure

ADDIE Steps	Activity
Analysis	a. Analysis of field conditions
	b. Media needs analysis
Design	a. Designing the prototype
	b. Designing materials
	c. Designing the instrument
Development	a. Product development
	b. Validation and feasibility test
Implementation	a. Product implementation
	b. Effectiveness test on students' disaster awareness
Evaluation	a. Product evaluation
	b. Product dissemination

The research test subjects consisted of 36 fifth-grade students at elementary schools affected by the eruption of Mount Semeru, namely SDN Sumberwuluh 2. The research design used to see the effectiveness of the product with one-group pretest-posttest design by conducting an initial test (pretest) and then a final test (posttest) after using the product. The media developed was tested by validators, namely media expert validators and material expert validators, and then tested on students. The types of data obtained are qualitative and quantitative data. Qualitative data was obtained from criticisms, suggestions, and responses from validators, teachers, and students based on the development of GeoWeb Semeru. Quantitative data is obtained from the results of the percentage value of the media feasibility test and the effectiveness test of GeoWeb Semeru on student disaster awareness.

The techniques used in the data collection process are interviews, questionnaires, and tests. The data collection instrument use open and closed questionnaires combination and interview guidelines. The open and closed questionnaires combination was distributed to students and teachers for determine the feasibility product developed [35]. While the test instrument related to the Semeru Volcano eruption disaster to determine students' understanding of disaster awareness. The value of students' disaster awareness is obtained with a knowledge test assessment instrument before (pretest) and after (posttest) using GeoWeb Semeru.

The data analysis technique uses quantitative descriptive analysis. The percentage result data is then converted into descriptive sentences [36]. Data from validation

results were converted into a percentage to see the feasibility of the media using the following formula:

$$\text{Percentage} = \frac{\text{Score obtained}}{\text{Maximum score}} \; x \; 100\ \% \quad (1)$$

The data obtained from the feasibility percentage is then classified on the feasibility criteria shown in Table 2. Before the effectiveness test stage, tests were carried out on the research instruments used, the validity and reliability test. The effectiveness test was obtained from the pretest and posttest disaster awareness scores of students obtained from the knowledge score. The effectiveness test is carried out by parametric or non-parametric test according to the results after the prerequisite test, including normality test and homogeneity test. If the data is normally distributed and homogeneous, then use a parametric test with an independent sample t test. Meanwhile, if the data is not normal, it uses a non-parametric test. The research hypothesis is H_0: GeoWeb Semeru is not effective in increasing students' disaster awareness, H_1: GeoWeb Semeru is effective in increasing students' disaster awareness.

Table 2. Classification of feasibility and effectiveness media

Score range (%)	Qualification
81-100	Very Feasible/Very Effective
61-80	Feasible/Effective
41-60	Sufficient Feasible/Sufficient Effective
21-40	Less Feasible/Less Effective
0-20	Unfeasible/Uneffective

Source: [37]

3 Result and discussion

The research results are presented in five sections according to the stages of the ADDIE model. The first section presents the results of the needs analysis. The second section describes the product design. The third section develops the product. The fourth section presents the results of product implementation. The last section summarizes the product evaluation.

3.1 Analysis

The analysis stage includes activities to analyze field conditions and analyze the needs of media development by teachers and students. The activity of analyzing field conditions is carried out by conducting observations of schools using interviews with teachers to find out the problems that occur in schools related to student disaster awareness. The observation activities obtained the results that students still need a higher level of volcanic disaster awareness as evidenced by the limited knowledge of students who only know the impact of eruption and do not know the steps taken before, during, and after a disaster. Meanwhile, the media needs analysis activity was carried out by giving a media needs questionnaire to teachers and students, which aims to find out the

media needed by teachers and students in the learning process related to volcanic eruption disaster material. Based on the results of the media needs analysis, it is known that disaster learning at school has been carried out but has never used technology-based media, especially web applications. Students prefer to learn by seeing and listening, and are more interested if the learning process use media that is integrated with images and videos. Teachers and students support the development of technology-based media with digital features.

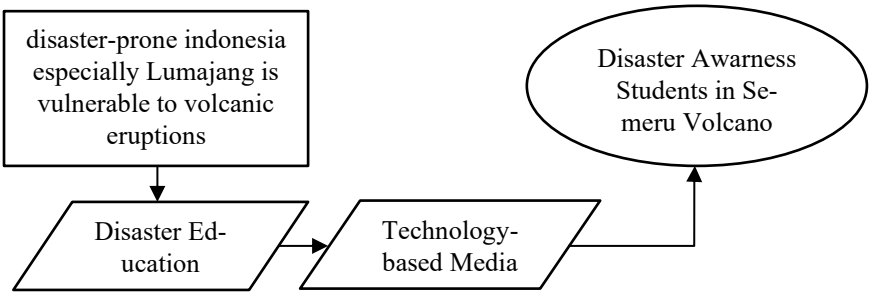

Fig. 1. Media needs analysis

3.2 Design

In the design stage, activities are carried out including designing prototypes, designing materials, and designing instruments. The material used in the product is related to Mount Semeru including location, history of eruption, danger and impact of eruption, and disaster mitigation of Mount Semeru eruption. Then the product prototype was designed using the Canva application by creating a display design and features that would be used. In the design stage, there were also activities to design the instruments to be used. The instrument consists of a media feasibility questionnaire and a student knowledge test related to Mount Semeru eruption disaster awareness. So that the design stage produces product prototypes, materials, and instruments that will be used.

3.3 Development

The development stage is the product realization based on the design stages that have been carried out previously. Product developed using Wordpress, an open application that can be used to create a web [38]. Wordpress was chosen because in the development process it use a simple programming language, there are many plugins and themes that can be used. The development activities resulted in the GeoWeb Semeru product.

GeoWeb Semeru is a web application with modern technology, namely progressive web app, which allows teachers and students to use it anytime and anywhere in the form of a web or application [39]. GeoWeb Semeru contains material about disaster mitigation more focused on the eruption of Mount Semeru. GeoWeb Semeru can be used on all types of digital devices such as cell phones and laptops. GeoWeb Semeru

can also be used by students both in poor internet conditions and even offline. GeoWeb Semeru display is flexible in portrait or landscape. GeoWeb Semeru can be used by students for learning activities about disasters, especially volcanic eruptions with media and features in the product such as material, videos, images, maps, and evaluation quizzes.

a. Landing page view

Fig. 2. Landing page view

On the GeoWeb Semeru landing page, the product title is displayed with the background of Mount Semeru. GeoWeb Semeru has a design or appearance that is in accordance with the material, which is related to disaster mitigation of Mount Semeru. The landing page consists of several pages that can be scrolled to see a little explanation about Mount Semeru, the location, impact, and danger of Mount Semeru, as well as the features contained in GeoWeb Semeru. On the landing page there are also several menus that can be accessed by students in the learning process related to disaster mitigation of the eruption of Mount Semeru.

b. Information menu display

Fig. 3. Information menu display

The information menu contains a selection of material menus presented on GeoWeb Semeru. Students can access materials or information related to information about Mount Semeru, the location of Mount Semeru, the impact of Mount Semeru eruption, and disaster mitigation of Mount Semeru eruption. Material or information presented in the form of photos, images, and maps that can be accessed by students flexibly.

c. Material display

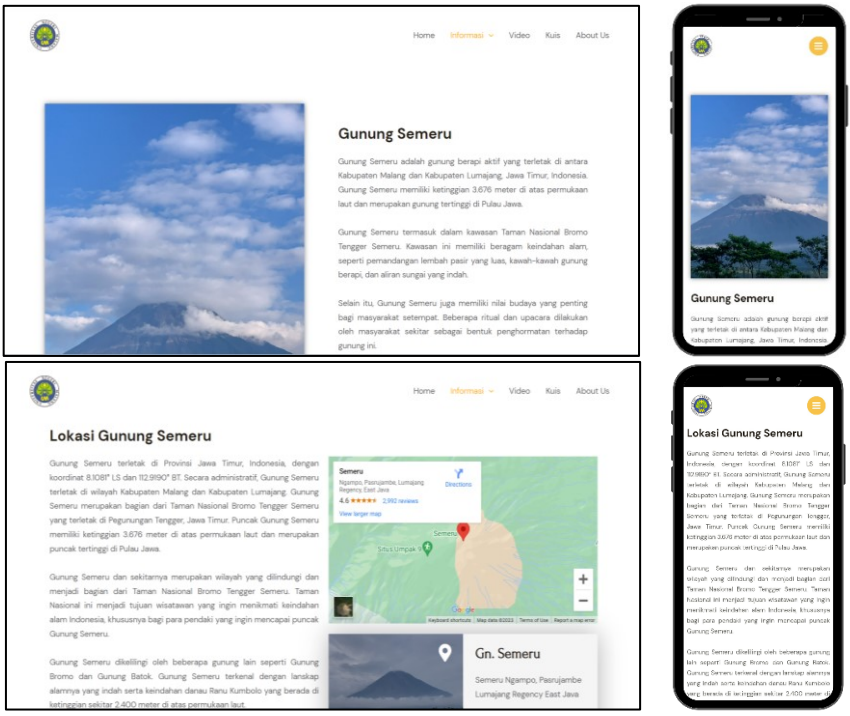

Fig. 4. Volcano semeru material display

The Mount Semeru information menu contains a description or general explanation related to Mount Semeru such as height, location, area or area of Mount Semeru. The Mount Semeru information menu also contains the history of the eruption of Mount Semeru which was first recorded. On the location information menu, it is explained related to the location of Mount Semeru which is equipped with an address and position or location displayed with maps so that students can see and know directly the location of Mount Semeru and its real appearance from above. This can foster a feeling in students about how big Mount Semeru is.

Fig. 5. Eruption impact material display

The eruption impact menu, the dangers and impacts caused by the eruption of Mount Semeru are presented, as well as an explanation of the material resulting from the eruption of Mount Semeru which can disturb students' health. Explanations related to hazards and impacts are also accompanied by direct images or photos of the impacts caused by the eruption of Semeru in 2021 and 2022.

Fig. 6. Disaster mitigation material display

The eruption disaster mitigation menu, an explanation is given about mitigation or steps that must be taken by students when an eruption of Mount Semeru occurs. So that the existence of information related to the dangers and mitigation of the eruption of Mount Semeru can foster student awareness and preparedness in the face of disasters.

d. Video menu display

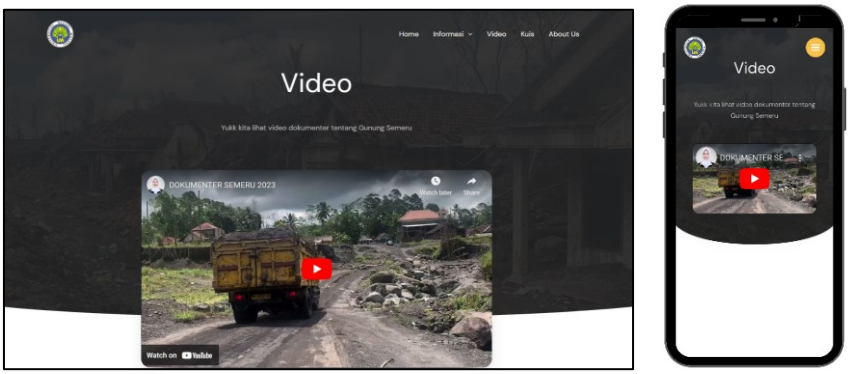

Fig. 7. Video menu display

GeoWeb Semeru is also equipped with a video feature. On the video menu, students are given a documentary video related to the dangers and impacts caused by Mount Semeru after the eruption that occurred in 2021 and 2022. The aim is that students can get a direct and clear picture of how powerful the power of Mount Semeru is, so that it can indirectly inspire feelings to be more aware and ready when a Mount Semeru eruption disaster occurs.

e. Evaluation quiz view

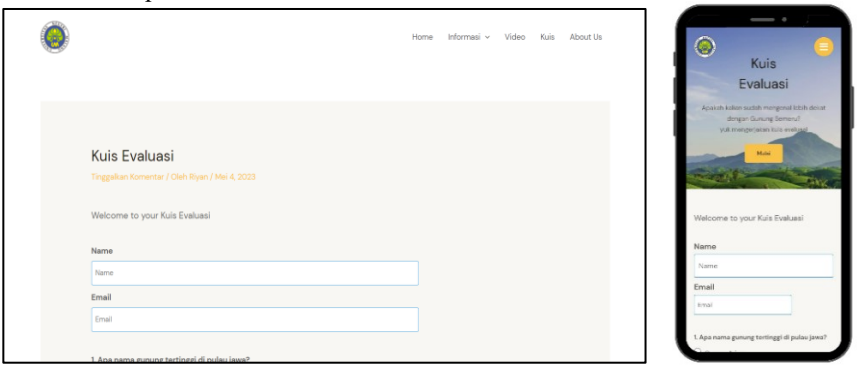

Fig. 8. Evaluation quiz view

GeoWeb Semeru is also equipped with an evaluation quiz feature. The evaluation quiz feature can be used as an assessment or evaluation material in the learning process related to the Mount Semeru disaster. The evaluation quiz consists of 10 multiple choice questions that contain questions based on the material learned using GeoWeb Semeru. GeoWeb Semeru use a domain and hosting system that can store data online on the system so that teachers can directly monitor the acquisition of evaluation quiz results.

After developing GeoWeb Semeru, a validation test was conducted to see the feasibility of the media. The validation test was carried out by material expert validators and media experts by being given a validation questionnaire consisting of several aspects of assessment. The validation results are presented in table 3.

Table 3. Material validation results

No	Criteria	Percentage	Qualification
1	Quality of content and goals	80 %	Feasible
2	Instructional quality	88 %	Very feasible
3	Technical quality	80 %	Feasible
4	Evaluation questions	87 %	Very feasible
	Total	84 %	Very feasible

The results of the material validation shown in Table 3 obtained an assessment of the material based on four criteria, the quality of content and objectives obtained a percentage value of 80%, on the instructional quality criteria obtained a percentage value of 88%, on the technical quality criteria obtained a percentage value of 80%, and on the quality criteria of the evaluation questions obtained a percentage value of 87%. Overall, the material on GeoWeb Semeru obtained a percentage value of 84%. With the acquisition of values it can be concluded that the material developed is very feasible in accordance with the range of values in the feasibility table.

Table 4. Media validation results

No	Criteria	Percentage	Qualification
1	Quality of content and goals	87 %	Very feasible
2	Instructional quality	95 %	Very feasible
3	Technical quality	82 %	Veri feasible
	Total	85 %	Very feasible

Table 4 presented the results of media validation using three assessment criteria, the quality of content and objectives obtained a percentage value of 87%, the instructional quality criteria obtained a percentage value of 95%, and the technical quality criteria obtained a percentage value of 82%. Overall, the media obtained a percentage value of 85%. Based on the feasibility table, the media can be classified as very suitable for use.

After the validation test, a product trial was conducted to determine the feasibility and response of students and teachers to GeoWeb Semeru. The trial was conducted on 36 elementary school students who were directly affected by the eruption of Mount Semeru, namely SDN Sumberwuluh 2. The trial was conducted directly by giving questionnaires to students. The aspects used as an assessment of media feasibility consist of aspects of media display, material aspects, and aspects of use. Each aspect of the assessment consists of five indicator items that must be filled in by teachers and students with assessment criteria, namely strongly disagree, disagree, agree, and strongly agree.

Table 5. Media trial results

No	Criteria	Percentage	Qualification
1	Media display	91 %	Very feasible
2	Material	91 %	Very feasible
3	Usage	88 %	Veri feasible

Total	90 %	Very feasible

Based on the results of the trial to teachers and students, the results of the media feasibility value, in the aspect of media display obtained a percentage value of 91%, in the aspect of material obtained a percentage value of 91%, and in the aspect of use obtained a percentage value of 88%. Overall, the media feasibility value based on teacher and student responses is 90%. Based on the feasibility table, it can be concluded that GeoWeb Semeru is very feasible to use.


Fig. 9. Product trial

3.4 Implementation

The implementation stage of GeoWeb Semeru aims to measure the effectiveness of the media on students' disaster awareness. The implementation stage was carried out on students of SDN Sumberwuluh 2 because it is a school directly affected by the eruption of Mount Semeru. Implementation was carried out on 36 fifth-grade students using a one group pretest-posttest design by comparing students' initial test scores with final test scores after using GeoWeb Semeru. Before testing the effectiveness of the media, a prerequisite test was conducted to determine the effectiveness test using parametric or non-parametric test. The prerequisite test consists of normality test and homogeneity test. The normality and homogeneity test are shown in table 6.

Table 6. Normality test results

Value	Kolmogorov-Smirnov Sig.	Qualification
Pretest value	0.000	Not normal
Posttest value	0.000	Not normal

The normality test is carried out using Kolmogorov-Smirnov aims to determine whether the data has a normal distribution or not. Data decision making is normally distributed if the value > 0.05. Based on the results of the normality test on students' pretest and posttest scores, the value of both is 0.000. With the predetermined decision making, the data from the normality test results < 0.05, so it can be concluded that the data has an abnormal distribution.

Table 7. Homogenity test result

Value	Levene Statistic Sig.	Qualification
Pretest and Posttest value	0.978	Homogen

The homogeneity test is carried out using Levene Statistic aims to see whether the data is homogeneous or not. The homogeneity test results obtained a value of 0.978 with data decision making is homogeneous if the value > 0.05. With the acquisition of the homogeneity value, it can be concluded that the data is homogeneous because the value is 0.978 > 0.05. The prerequisite test that has been carried out obtained the results that the data has an abnormal distribution and is homogeneous so that the effectiveness test uses a non-parametric test, namely with mann whitney.

Table 8. Mann whitney test result

Students Disaster Awareness	Value
Mann Whitney U	294.500
Sig. (2 tailed)	0.000

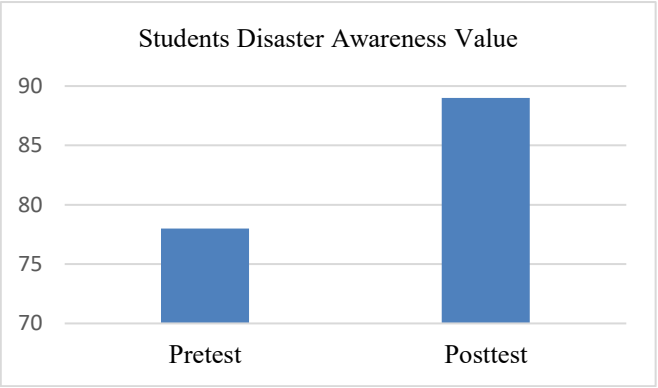

Fig. 10. Students disaster awareness value

Based on the results of the mann whitney test, the value obtained is 0.000 with the significance level used is 0.05. Decision making if the value < 0.05, then there is a rejection of H_0 and acceptance of H_1. If the value > 0.05, then there is acceptance of H_0 and rejection of H_1. The mann whitney test results show a value of 0.000 < 0.05, so it can be concluded that H_1 is accepted which means that GeoWeb Semeru is effective in increasing students' disaster awareness, which is supported by the acquisition of posttest scores higher than the students' pretest scores.

GeoWeb Semeru based on progressive web app effectively increases students' disaster awareness with easy and flexible access that can be utilized by teachers and students at any time regardless of internet connection. GeoWeb Semeru can be used on any digital device with information about Mount Semeru such as location, hazards,

impacts, and disaster mitigation presented visually and attractively so that students can learn with new experiences, so that students are more memorable and can understand about disaster risks around them.

3.5 Evaluation

At the evaluation stage which includes product revision and dissemination activities. In the implementation process, GeoWeb Semeru received positive responses from teachers and students, so no revisions were made to the media. Then product dissemination was carried out by providing the GeoWeb Semeru link to teachers at SDN Sumberwuluh 2.

Based on the study results, it can be concluded that the student's responses to GeoWeb Semeru are positive and feasible to use. Previous research on technology-based learning media has been widely carried out [40], [41]. For example, the development of web-based learning media is used to improve disaster knowledge [42], disaster preparedness [43]. However, the developments aimed at junior and senior high school levels. In contrast, children at the elementary school level are the most vulnerable, especially in elementary schools around Mount Semeru. Therefore, this study was conducted. Another thing that underlies this study is disaster awareness students around Mount Semeru are still low. GeoWeb Semeru can be considered to increase the awareness of elementary school students around Mount Semeru.

By comparing with previous research, this study found that an innovative technology-based disaster learning tool through the development of GeoWeb Semeru has provided students with a better understanding of disasters, especially the eruption of the Semeru volcano. The digital features of GeoWeb Semeru learning media, such as materials, videos, and evaluation quizzes are one of its advantages. Visualizations presented by learning media about Semeru volcano, such as location, eruption history, hazards, impacts, and disaster mitigation that can create new and memorable learning experiences for students. The following are details of the findings of this research: 1) GeoWeb Semeru, accompanied by images and text, can display material about the Semeru volcano disaster so that it increases students' disaster information-related capacity. 2) the use of GeoWeb Semeru for learning media help teachers and students collaborate so as to increase students' cognitive and affective experiences. 3) the utilization of GeoWeb Semeru in learning makes students able to understand mitigation steps so that it increase students' disaster awareness, accompanied by a quiz as an evaluation tool.

4 Conclusion

GeoWeb Semeru is a web application that utilizes modern web technology in presenting information about eruption disasters and Mount Semeru in an interactive and easily accessible way for students. The development of GeoWeb Semeru aims to increase disaster awareness of elementary school students around Mount Semeru

towards potential disasters around them, especially related to the activities of Mount Semeru. With the presentation of information packaged with visuals, students can better understand the risks of disasters and the steps that must be taken when a disaster occurs. The results showed that GeoWeb Semeru is very feasible and effective in increasing students' disaster awareness. Thus, GeoWeb Semeru can be an innovative solution in increasing disaster awareness of elementary school students.

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