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Implementation of Wildfire Disaster Modelling in Science Education to Increase Students' Awareness

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Abstract

Land fires are one of the biggest disasters in Indonesia that occur every year and are important to anticipate. However, fire learning is more in science learning than in social studies learning, even though both require basic knowledge about local disasters. One of the learning efforts that can be done is the use of land fire modeling in learning to increase students' disaster awareness. Therefore, this study aims to determine the effect of wildfire disaster modelling on students' awareness of disaster. This quantitative study uses the One-Group-Pretest-Posttest Design method. The subjects of this study were 50 seventh grade junior high school students. The results of this study indicate an increase in students' disaster awareness in social studies education which was previously in the moderate category then became a high category after land fire modeling was carried out. With a T-count value of 5.365> T-table value of 2.000 and a significance value of 0.00 <0.05 so that Ha is accepted. As for the recommendation, the data collected by distributing land fire awareness questionnaires before and after the land fire modeling demonstration was too narrow. Further research should be conducted on more students and course not only from science education.

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Introduction

Land wildfires are natural disasters that occur every year in various countries and have an impact on human activities (Li et al., 2023). Especially in some areas, haze disrupts students' activities. However, students often do not have awareness of disasters that cause them to be unable to act when haze occurs, such as the still high mobility of children outdoors and a lack of understanding of the behavior taken in dealing with disasters (Holm et al., 2021). When this happens in the surrounding community, public awareness, especially among students, is very low, so it is rare to find the surrounding community taking the necessary steps to prevent wildfires, even if identifying that the surrounding community is the cause of wildfire events (Calamba, 2024; Wulandari et al., 2023). This happens because social science learning in schools still does not provide disaster or environment issue awareness to students (Shaw et al., 2009). Learning generally only emphasizes natural science learning compared to social science actions, even though when a disaster occurs, the most important thing is awareness in dealing with it. Awareness is key to forming a society that cares and is sensitive to its surroundings, especially environmental disaster issues (Seddighi et al., 2020). However, the surrounding community's lack of self-awareness, especially students, results in wildfires that can occur at any time. These wildfires can have significant impacts on the surrounding environment and global climate change (Firmanshah et al., 2023; Putra et al., 2011). Lack of awareness has a negative impact on students' social activities and can even threaten the health and lives of vulnerable students. Various studies have shown the low level of disaster awareness of students, especially high school students, so appropriate learning methods, models and strategies are needed to increase students' disaster awareness. One of them is by using modeling, because it can provide an overview of the causes, impacts and processes of a disaster and its dangers to human activities.

The indifference of the surrounding community, especially students, to wildfires, could be due to ignorance of the long-term impacts of such events as climate change. A study conducted with 1600 respondents showed that 52% of the respondents believed climate change would have an impact on life, while the other 48% did not believe that climate change would have an impact on life (Njoku, 2016). The data showed that only about 50% of the population was aware of climate change and believed that these changes would affect daily life. The neglect of wildfires and their relationship to climate change is a serious problem that must be addressed immediately. One of which is by using education, especially environmental education, with modeling that can instill awareness about the impact of wildfires, focusing on climate change.

Awareness referred to in this study is the cognitive awareness of students related to wildfires to climate change in accordance with the indicators and questionnaire statements provided. The *awareness* assessment category is measured by a questionnaire in the form of a statement according to the topic used. Comparison of answers to the results of students' level of awareness before and after modeling is grouped into low, medium, and high levels. Increasing awareness using modeling can be a simple, safe, and economical solution (Aliman et al., 2019; Delcea & Liviu-Adrian, 2019). The use of modeling in learning aims to reveal students' thinking processes, facilitate the exchange of thoughts between students and educators, and help students learn to apply modeling thinking in everyday life (Bal & Doganay, 2014; Wilson et al., 2020).

The modeling was designed using two terrariums covered with plastic to measure the temperature difference between them (Suryawirawati et al., 2018; Wulandari et al., 2021) To illustrate the relationship between climate change and wildfires, one of the terrariums is connected to a hose to model wildfires (Rima et al., 2020). In the learning process, modeling is done experimentally and actively involves students developing their understanding (Halloun, 2007). This study aimed to determine the impact of wildfire modeling in social science education on the level of awareness of seventh-grade students on climate change material.

Land wildfire modeling plays an important role in science education to increase students' disaster awareness. Models are used to stimulate realistic situations that occur when a fire disaster strikes and help students understand the mechanisms, mitigation, impacts, awareness and sensitivity to disasters (McCaffrey, 2015). Several studies have been conducted in the form of developing wildfire models to increase students' disaster awareness, namely the development of interactive fire modeling modules that teach the concept, management and impact of fires on society and the environment. The model is in the form of maps and computer simulations of wildfire incidents (Goldammer, 2013). Many research results show an increase in students' wildfire disaster awareness. Another development is a simulation tool in the form of virtual reality (VR) to increase disaster awareness in the form of VR containing fire situations for students so that they can understand fire behavior, causal factors and rescue actions that can be taken (Harrison et al., 2020). Another study is a wildfire simulation for evaluating education programs in increasing disaster awareness for students. The results show student participation accompanied by an increase in understanding and preventive and responsive readiness for fire disasters (McCaffrey, 2018). Other modeling developments include role-playing games as fire managers that contain concepts of risk management, emergency decision-making, and coordination between institutions in disaster management (Solińska-Nowak et al., 2018). Wildfire modeling as a practical tool or learning media in science education provides an effective way to increase disaster awareness. These tools help students understand the complexity of forest and land fires, prepare them to deal with disasters more proactively, and encourage them to contribute to future fire risk mitigation and management efforts.

Method

This research is a quantitative type of research with the *One-Group-Pretest-Posttest Design* research design refers to Table 1, where this design has a *pretest* before treatment. Therefore, the post-test results after treatment can be more accurate because they can compare them before and after treatment.

Table 1. One-Group-Pretest-Posttest Design

Pretest	Treatment	*Posttest*
O1	X	O2

Desc:

$\mathbf{O_1}$ = Experimental group before *treatment*

$\mathbf{O_2}$ = Experimental group after *treatment*

X = *Treatment* (use of teaching aids in the form of fire demonstration tools and environmental terrariums)

$\mathbf{O_2} - \mathbf{O_1}$ = assumed to be the result of *treatment*

The subjects in this study were about 50 students from class VII Junior High School, who were selected using a random sampling technique.

Validity Test

This validation test was carried out to find out which statements were declared valid and could be used to collect data, with the formula used:

$$r_{xy} = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{(n\sum y^2 - (\sum x)^2)(n\sum y^2 - (\sum y)^2)}}$$

Desc:

r_{xy} = the correlation index number of the statement score (X) with the total score (Y) or "r" *product moment*

n = number of respondents

$\sum xy$ = sum of the multiplication of X score and Y score

$\sum x$ = sum of X scores

$\sum y$ = sum of Y scores

Reliability Test

This study's reliability test was carried out using the SPSS Statistics version 26. The technique used was the *Cronbach Alpha* formula, where a reliability of less than 0.6 is moderate. At the same time, 0.7 is strong, and above 0.8 is very strong (Suryani et al., 2017), which means that if the reliability value is greater than 0.7, the instrument items can be said to be reliable and trusted as a data collection tool in this study.

$$r_i = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum \sigma_b{}^2}{\sigma_t{}^2}\right)$$

$\sum \sigma_b{}^2$ = jumlah varians butir

$\sigma_t{}^2$ = varians total

Normality Test

The normality test was tested on the SPSS Statistics version 26 with the Kolmogorov-Smirnov formula, whose criteria are indicated by the Asymp. Sig. which is equal to 0.05 or greater. Based on these criteria, it means the distributed data is normal.

Linearity Test

Linearity testing was carried out to determine the linear relationship between the independent variable (X) and the dependent variable (Y). This test was carried out by using the SPSS Statistics version 26 with the criteria for

assessing the linearity significance value greater than 0.05, in which there is a linear relationship between the independent and dependent variables. Conversely, if the linearity significance value assessment is smaller than 0.05, it means that there is no linear relationship between the independent variable and the dependent variable

Hypothesis Test

Hypothesis testing in this study used a simple regression test using SPSS Statistics version 26. Regression means forecasting, a statistical technique (analytical tool) relationship with the regression line equation used to forecast or predict the assessment of a variable and its relationship with other variables. It explains the research methods, by steps systematically according to the objectives, ending with data analysis.

Results

The student *awareness* instrument sheet was validated by 3 expert lecturers and 2 science subject teachers at school. The questionnaire sheet used was also tested for validity and reliability (see Table 2).

Table 2. Summary of Reliability Test Results

Variables	Alpha Cronbach	N of Item	Interpretation
Students‘ awareness	0.817	27	Very strong reliability

(SPSS Statistic Version 26)

Based on data from Table 2, it could be concluded that *Cronbach's Alpha* value of 0.817 from a total of 27 statement items was said to be very high reliability. Therefore, after the validity test and reliability test, the statement items in the scale were used in this study. Validity Results at Table 3 shows person correlation and sig (2-tailed) from 27 indicator statement.

Table 3. Validity Test Results

Indicator Statement	Total_X		
	Pearson Correlation (≥0.361)	Sig. (2-tailed) (<0.05)	N
X1	0.374	0.042	30
X2	0.374	0.042	30
X3	0.417	0.022	30
X4	0.496	0.005	30
X5	0.385	0.035	30
X6	0.420	0.021	30
X7	0.447	0.013	30
X8	0.391	0.033	30
X9	0.386	0.035	30
X10	0.399	0.029	30
X11	0.371	0.043	30

Indicator Statement	Total_X		
	Pearson Correlation (≥0.361)	Sig. (2-tailed) (<0.05)	N
X12	0.388	0.034	30
X13	0.368	0.043	30
X14	0.463	0.010	30
X15	0.478	0.008	30
X16	0.429	0.018	30
X17	0.372	0.043	30
X18	0.384	0.036	30
X19	0.390	0.033	30
X20	0.409	0.025	30
X21	0.590	0.001	30
X22	0.395	0.031	30
X23	0.386	0.035	30
X24	0.532	0.002	30
X25	0.475	0.008	30
X26	0.431	0.017	30
X27	0.499	0.005	30

The instrument's validity in this study was tested on seventh-grade students at Junior High School at Palembang in the 2023/2024 academic year. with 30 respondents on Tuesday. February 28. 2023. The 27 statements filled in by students as respondents were then processed using SPSS Statistics version 26. The results of the students' answers details in Table 4 and Table 5 to the pretest and posttest were from 50 respondents. with 6 indicators consisting of 27 statement items.

Table 4. Indicator Category Determination Results

Category	Criteria
Low	$1.88 < X \leq 2.86$
Medium	$2.86 < X \leq 3.84$
High	$3.84 < X \leq 4.82$

Table 5. Quantitative Analysis of Students' Pretest-Posttest Awareness Indicator

Indicator	Respondents	Mean		Std. V		Category	
		Pre	Post	Pre	Post	Pre	Post
Individual awareness of the impact of wildfires.	50	3.52	4.78	1	0.41	Medium	High
Individual factors cause wildfires.	50	3.46	4.72	1.03	0.45	Medium	High
Natural factors cause wildfires.	50	3.19	4.73	0.93	0.47	Medium	High
Individual initiatives in reducing the impact of wildfires by reforestation and habitat restoration.	50	3.24	4.8	0.91	0.41	Medium	High

Based on the data in Table 4, all indicators were in the medium category. It meant that these students had a fairly good level of *awareness of* the impact of wildfires on climate change. Meanwhile. the *posttest results* showed that all indicators were in the high category. It meant that these students had a good *awareness of* the impact of wildfires on climate change.

Table 6. Normality Test Results Unstandardized Residual

N		**50**
Normal Parameters[a.b]	Mean	.0000000
	Std. Deviation	7.25743121
Most Exreme Difference	Absolute	.085
	Positive	.054
	Negative	-.085
Test Statistic		.085
Asymp. Sig. (2-tailed)		.200[c.d]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance

Based on the normality test that was carried out, the significant value obtained from this study was 0.200. where the value was greater than 0.05. This meant that the data on students' *awareness of* the impact of modeling wildfires on climate change material was normally distributed. After that, a linearity test was carried out which is shown in Table 7.

Table 7. Linearity Test Results

Sum of Square				**df**	**Mean Square**	**F**	**Sig.**
Unstandardized Residual * Predicted Value	Between Groups	(Combined)	1254.437	13	96.495	2.619	.011
		Linearity	.000	1	.000	.000	1.000
		Unstandardized Deviation from Linearity	1254.437	12	104.536	2.837	.008
	Within Groups		1326.408	36	36.845		
	Total		2580.845	49			

Based on the linearity test that was carried out. the Sig value obtained from this study was 1.000. where the value was greater than 0.05. This meant that the data before the demonstration of wildfire modeling (X) and the data after the demonstration of wildfire modeling (Y) had a linear relationship. Finally, to determine the effect of modeling, a hypothesis test was carried out, the results of which can be seen in Table 8.

Table 8. Hypothesis Test Results

Model	Unstandardized Coefficients		Standardized Coefficients		
1		B	Std. Error	Beta	t	Sig.
	(Constant)	107.810	3.808		28.308	.000
	Total_X	.225	.042	.612	5.365	.000

a. Dependent Variable: Total_y

- **H0** = There is no impact of modeling wildfires on the level of *awareness of* students on climate change material.
- **Ha** = There is an impact of modeling wildfires on the level of *awareness of* students on climate change material.

It is known that the calculated t_{value} was 5.365> t_{table} value 2.000. and the significance value was 0.00 <0.05. Therefore, it could be concluded that the data variable before the demonstration of wildfire modeling (X) positively impacted the data variable after the demonstration of wildfire modeling (Y). (H_a was accepted). The assessment was calculated from the difference between the means of the two groups and the standard deviation. Statistical parameters are standard for all studies involving two variables.

4.74-3.350.98 = 1.41

Discussion

From the results of the *Pretest-Posttest* Quantitative Analysis of Students′ *Awareness* Indicators in Table 4, it is known that in the indicators of individual *awareness of the* impact of wildfires, the causes of wildfires by individual factors, the causes of wildfires by natural factors, individual initiatives in reducing the impact of wildfires by carrying out reforestation and habitat restoration, individual initiatives in reducing the causes of wildfires by avoiding forest function transfer practices, individual initiatives in reducing the impact of fires by carrying out waste management. The research results using this modeling were significant. with a significance value of 0.00 <0.05. where there was an increase in the analysis of the level of awareness of students using a questionnaire so that the value was in the high category. which was previously in the medium category.

According to Musahidin et al. (2022), the learning process through modeling with simple props causes students to actively ask questions. discuss with their groups and actively listen to explanations and discuss with the teacher so that they can build or construct their own knowledge on the material being studied. Modeling can stimulate concept understanding and increase *awareness of* previously abstract students then concretized with visual modeling equipped with simple props.

Some studies using modeling that are in line with the results of this study are related to the application of demonstration models to improve concept understanding (Hayatu & Hana, 2017) related to demonstrations to increase learning *awareness* (Deese et al., 2000) related to increasing students' understanding and metacognitive awareness through modeling (Musahidin et al., 2022) and related to modeling in students who improve characteristics (Chrysafiadi & Virvou, 2013). The study results showed a significant increase in students'

awareness of the topic presented. This is because students become more active and participate in learning activities by using the modeling demonstration method. Modeling activities in learning give students an overview of the material being taught so that students understand more about the material being taught because demonstration activities generally use visualization media or props. Students are also allowed to interact with the environment and other learners. which allows students to improve their ability to observe. conclude. and communicate to explain the learning in their own words.

Some of the responses of students during the learning process with wildfires modeling are: "Learning time becomes more enjoyable because it is outside the classroom"; "Learning is more exciting because you see firsthand how the process of wildfires occurs"; "There is rarely a practicum time for learning. so learning is more fun if there is a direct picture." Based on the research. learning using modeling can increase students' interest and curiosity. Even though the syntax used is simple. it can make students active in the learning process and participate in completing the assigned tasks. Learning activities are not boring because students observe directly and are involved in practicum activities with modeling so that students learn better and can achieve learning objectives.

Conclusion

Based on the research that had been done, it can be concluded that modeling wildfires had a significant effect on the level of *awareness in social science education for* students with a Sig value. This study showed a significant change in students' level of awareness from previously in the medium category to the high category related to the impact of wildfires with climate change through the modeling practicum conducted. This is because students can learn better and more fun. After all they are facilitated by practicum to examine a concept. interact directly. and analyze the results easily.

Recommendations

Future research and classroom practice should expand the implementation of wildfire disaster modelling by involving larger and more diverse student samples across different schools and grade levels, and by integrating the approach into interdisciplinary learning beyond science (e.g., social studies and civic education) to strengthen real-life relevance. To improve the quality of evidence, studies should employ stronger designs such as quasi-experiments with control groups, use richer data collection methods (observations, interviews, performance tasks, and reflective journals) in addition to questionnaires, and conduct follow-up assessments to examine long-term retention of disaster awareness. Finally, modelling activities should be connected to practical mitigation actions and enhanced through interactive or digital simulations so that students not only understand wildfire risks but also develop sustained awareness and responsible behavior.

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