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RESEARCH ARTICLE

Analysis of Students' Understanding of Population and Environmental Education in the Context of Hydrometeorological Disasters

Yusriani Sapta Dewi, Deni Kurniawan*

Universitas Satya Negara Indonesia

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***Corresponding Author:**

yusrianisaptadewi@usni.ac.id

ABSTRACT

This study aims to analyze students' understanding of population and environmental education in relation to hydrometeorological disasters. These disasters can lead to fatalities, health deterioration, economic displacement, large-scale urbanization, injuries, and significant financial losses. Effective disaster response requires interdisciplinary collaboration to mitigate risks. Students' lack of knowledge, understanding, and preparedness regarding hydrometeorological disasters highlights the need for further study. Disaster education should begin in the closest environment, such as within families, supported by government initiatives and coordination with relevant agencies. The research used non-experimental quantitative approach with survey method, and Universitas Satya Negara Indonesia's students as the population. Random sampling technique was applied to select 136 participants. Data collection was conducted using a questionnaire with Likert scale, and data analysis was performed using SEM PLS Professional software version 3.2.4. The study's findings indicate that Cognitive Education Environment (CEE), Attitude Education Environment (AEE), and Psychomotor Education Environment (PEE) have positive and significant impact on students' understanding of hydrometeorological disasters (HDS). This suggests that improving cognitive, attitudinal, and psychomotor education environments enhances students' comprehension and preparedness for hydrometeorological disasters.

INTRODUCTION

Indonesia is located at the meeting point of three active tectonic plates, making the country prone to natural disasters. Disasters are a series of events that can disrupt and adversely affect lives, as well as the economy. These events may be caused by natural or non-natural factors, resulting in loss of life, environmental destruction, property damage, the collapse of public infrastructure, and psychological distress in post-disaster situations (BNPB, 2007).

Disasters can be classified based on their causes, the environment in which they occur, and their speed (Tuladhar, Yatabe, Dahal, & Bhandary, 2014) and categorized into two: natural and man-made disasters (Ronan & Johnston, 1999).

Hydrometeorological disasters are disasters caused by extreme climate (Wu, Huang, Tang, Kirschbaum, & Ward, 2016) and the interaction between hydrological and meteorological elements, such as extreme changes in weather (Muliadi & Warsidah, 2024). Around 98% of the total natural disasters are hydrometeorological disasters that lead to many fatalities, such as droughts, landslides, floods, forest and land fires, and sea waves (Chung & Yen, 2016), many of which could be linked to water, the atmosphere, and oceanic phenomena. In Indonesia, 86% of all disasters are classified as hydrometeorological, including floods, tornadoes, landslides, forest and land fires, and droughts

(Dwinanda, et al., 2024). Hydrometeorological disasters lead to fatalities, declining public health, economic displacement, large-scale urbanization, injuries, and financial losses. Addressing these risks requires an interdisciplinary approach and collaboration across various sectors to develop effective disaster response strategies (Dai & Azhar, 2024).

Indonesia faces severe environmental challenges, including unregulated exploitation of forests and marine resources, severe air and water pollution, and rapid population growth, many of which contribute to climate change. Climate change, a global environmental crisis, has diverse and far-reaching effects across countries and regions, including Indonesia, which lies in Southeast Asia and is particularly vulnerable to its impacts (Rochimah, Rasyid, & Sofian, 2023). Climate change in this region requires adaptation and mitigation strategies, since farmers' lives are highly dependent on the natural environment and climate factors (Malhi, Kaur, & Kaushik, 2021).

To mitigate the impact of climate change, the government must implement comprehensive and integrated adaptation strategies that involve all sectors. These efforts should align with Indonesia's National Action Plan for Climate Change Adaptation (RAN-API), which serves as the country's framework for resilience and sustainable environmental management (Putra, Dewata, & Gusman, 2021). One of these efforts is environmental education for every part of the society. Education is the ideal medium for instilling and transforming individuals' beliefs, values, knowledge, and skills, fostering both personal growth and societal development (Edgerton & McKechnie, 2023). According to the North American Association of Environmental Education (NAAEE) (2001), environmental education is a comprehensive process aimed at enhancing human understanding of the environment and its problems (Siddiq, Supriatno, & Saefudin, 2020).

An individual's ability to respond to a disaster is determined by their preparation, knowledge, and actions taken during the event (Fazeli et al., 2024). For decades, Indonesia's poor environmental conditions have led to concerns about local environmental knowledge, attitudes, and values among its population. To build environmentally conscious citizens, it is essential to identify various forms of education and environmental that may be applied across different contexts (Parker & Prabawa-Sear, 2020). Environmental education in educational institutions appears to be one of the most effective approaches to fostering the necessary transformation in young people, guiding them toward responsible environmental behavior (Parker & Prabawa-Sear, 2020). Population and environmental education plays a crucial role in building positive environmental behavior, which may help protect natural resources from damage and degradation (Yadav et al., 2022). Understanding natural disaster mitigation includes learning, emergency response planning, disaster warnings, and resource mobilization. However, the government alone cannot implement all mitigation efforts. Therefore, disaster education must extend beyond schools to include families and communities to help enhance their mitigation knowledge and preparedness (Annisa, Asrani, Serlinda, Kasih, & Maulana, 2022).

Although the government has made several efforts to address environmental problems (Parker & Prabawa-Sear, 2020), most students are still unsure about what to do when a disaster occurs, especially regarding evacuation plans, hazards, and disaster-prone areas (Rayos, Arcilla, Jacoba, & Mundo, 2024) This is exacerbated by the low level of environmental awareness among the Indonesian population. International assessment tests indicate that Indonesian students significantly lag in scientific knowledge, highlighting the need for stronger environmental and science education (OECD, 2016). Moreover, the integration of population and environmental education with natural science subjects in the country is still relatively limited. (Mithen, Onesimus, Arfandi, Raeny, & Rahmansyah, 2021), mainly due to the perception that the subject is a burden on students' learning time. In addition, lack of coordination among relevant institutions, insufficient funding, and ineffective program structure create further challenges (Mahaswa, Prayuda, & Riziq, 2024).

It is hoped that with better environmental education, students will develop a better understanding of environmental issues, acquire disaster management skills, and be able to educate their families and communities, contributing to the Indonesian government's efforts in natural disaster prevention (Ratnaningsih, 2020). The environment is very important for human, and protecting it is a shared responsibility to ensure its sustainability for future generations (Husaini, Ruswandi, & Erihadiana, 2023).

Understanding population and environmental education in relation to hydrometeorological disasters can benefit both students and the community. This study aims to analyze students' understanding of population and environmental education concerning hydrometeorological disasters. The competency standards of the population and environmental education course are designed to equip students with: Cognitive Education Environment (CEE), Attitude Education Environment (AEE) Psychomotor Education Environment (PEE), which are essential for understanding and addressing population and environmental challenges (Rende, 2024). The three psychological domains related to learning outcomes in integrated population and Environmental Education are (1) cognitive domain; (2) affective domain; and (3) psychomotor domain (Schmäing & Grotjohann, 2023). The most effective way for students to develop environmental understanding is through direct interaction with real-world environmental challenges in their surroundings (Santoso, Tang, & Jumadi, 2021). In general, students exhibit low environmental awareness, primarily due to a lack of knowledge about the consequences of their actions on the environment (Hadi & Masruri, 2014). A strong correlation exists between students' perception, attitude, and environmental awareness and their understanding of environmental pollution (Sholikhah & Shofiyah, 2024).

Key components of students' understanding of population and environmental education in relation to hydrometeorological disasters (HDS) include longer dry seasons, droughts, changing weather conditions, decreased rainfall, climate change and its impact on agriculture, global warming, low water sources, lower crop quality and yield, slash-and-burn practices and deforestation, training programs, technical and basic knowledge related to disaster adaptation and mitigation, access to the latest agricultural technology, and maintain communication with stakeholders and organizations (Komarudin, Fahrunnisa, Afgan, & Ardiantoro, 2024).

In this study, students' understanding of population and environmental education is defined as an educational program designed to foster knowledge, awareness, attitudes, and responsible behavior regarding the reciprocal relationship between population and the environment. The following indicators were used to determine their understanding: The current dry season is longer than in the past (PEE1), more droughts and unusual weather events have occurred in recent years (PEE2), lower rainfall compared to previous years (PEE3), weather conditions have changed significantly over time (PEE4), climate change has significant impact on agriculture (PEE5), global warming is occurring (PEE6), climate change is ongoing or has already occurred (PEE7), water sources are running out due to climate change (PEE8), climate change is causing a decline in harvest quality (PEE9), lower number of plants due to climate change (PEE10), slash-and-burn practices contribute to climate change (PEE11), deforestation accelerates climate change (PEE12), it is important to participate in climate change training programs from government agencies (PEE13), technical and fundamental knowledge of climate change adaptation and mitigation is necessary (PEE14), access to the latest agricultural technology enhances climate resilience (PEE15), and maintain communication with stakeholders and organizations (PEE16).

Meanwhile, indicators of hydrometeorology understanding include: understanding public comprehension of meteorological data, utilization of weather information to reduce the risk of hydrometeorological disasters, and the public's follow-up response (Radjab, 2021). If environmental education improves, people will be better prepared and more capable of protecting themselves from disasters. Effective environmental education should begin with understanding the causes of disasters and preventive measures to mitigate disaster risks. (Prasetyo, 2022).

In this study, understanding hydrometeorological disasters refers to the comprehension of disasters caused by the interaction of hydrological and meteorological elements, leading to extreme weather changes. This understanding is assessed through the following key indicators: understanding community awareness regarding weather information (HDS1); receiving or accessing weather updates (HDS2); availability of sources or means to obtain weather data (HDS3); application of weather information to reduce the risk of hydrometeorological disasters (HDS4); sharing weather updates with family, friends, and social circles (HDS5); understanding the content of weather information (HDS5); utilizing weather forecasts to support day-to-day activities (HDS6); the public's follow-up measures (HDS7); recognizing the importance of preparedness for hydrometeorological disasters such as floods, flash floods, and landslides (HDS8); understanding weather information issued by the Meteorology, Climatology, and Geophysics Agency (BMKG) and its relevance to disaster (HDS9); taking proactive disaster preparedness steps based on weather forecasts (HDS10); implementing preventive measures before disasters occur (HDS12), responding appropriately during a disaster (HDS13), carrying out post-disaster recovery efforts (HDS14), and ability to effectively reduce disaster risk levels (HDS15).

MATERIALS AND METHODS

The research was conducted at Universitas Satya Negara Indonesia using a non-experimental quantitative approach. Data collection was carried out through a survey method using a questionnaire.

The study population consists of all students at Universitas Satya Negara Indonesia, with random sampling applied to select a sample of 136 students. Data was collected using a Likert-scale questionnaire to measure responses.

For data analysis, the study utilized SEM PLS Professional software version 3.2.4 to examine relationships between variables and assess research findings.

RESULTS

The evaluation of outer models was conducted to assess the reliability and validity of the research model. This evaluation involved several tests, including: Discriminant validity tests; Convergent validity tests; Composite reliability values; Average Variance Extracted (AVE)

The outer model represents the correlation between latent variables and their indicators. The outer loadings indicate the strength of the relationship between an indicator and its construct. Higher outer loadings suggest that the indicator contributes significantly to the measurement model, reinforcing the validity of the construct.

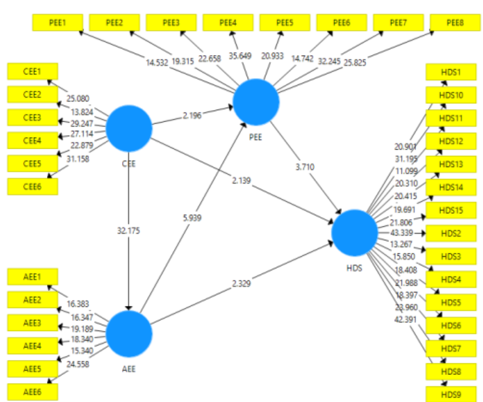

Figure 1. Evaluation of measurement model (outer models)

Table 1. Outer loadings

No	Indicators	AEE	CEE	HDS	PEE
1	AEE1	0.810			
2	AEE2	0.797			
3	AEE3	0.828			
4	AEE4	0.841			
5	AEE5	0.835			

No	Indicators	AEE	CEE	HDS	PEE
6	AEE6	0.877			
7	CEE1		0.893		
8	CEE2		0.763		
9	CEE3		0.892		
10	CEE4		0.883		
11	CEE5		0.854		
12	CEE6		0.902		
13	HDS1			0.856	
14	HDS10			0.860	
15	HDS11			0.720	
16	HDS12			0.842	
17	HDS13			0.829	
18	HDS14			0.826	
19	HDS15			0.825	
20	HDS2			0.877	
21	HDS3			0.754	
22	HDS4			0.802	
23	HDS5			0.805	
24	HDS6			0.827	
25	HDS7			0.842	
26	HDS8			0.852	
27	HDS9			0.877	
28	PEE1				0.809
29	PEE2				0.840
30	PEE3				0.865
31	PEE4				0.902
32	PEE5				0.852
33	PEE6				0.810
34	PEE7				0.890
35	PEE8				0.885

This study applied a standard outer loading threshold of 0.7. The results indicated that all outer loading values exceed 0.7, signaling strong correlation between indicators and their respective constructs.

The Average Variance Extracted (AVE) was used to measure the proportion of variance captured by the construct compared to variance caused by measurement error. For validity, the AVE value should be greater than 0.5, ensuring that the construct explains more than half of the variance of its indicators.

Table 2. Average Variance Extracted (AVE)

Latent Variable	Average Variance Extracted (AVE)
HDS	0.684
CEE	0.750
AEE	0.692
PEE	0.735

Table 2 presents the AVE values for the latent variables as follows: HBS: 0.684, CEE: 0.750, AEE: 0.692, PEE: 0.735. Since all AVE values exceed 0.5, the results confirmed that the convergent validity test was met, indicating that each construct explained more than 50% of the variance of its indicators.

Discriminant validity assesses the degree of differentiation between constructs that should not be correlated. It ensures that each construct is distinct from others within the research model. In this study, discriminant validity was evaluated using the Fornell-Larcker criterion, which compares the correlation of manifest variables within their respective latent variables.

Table 3. Fornell Larcker Criterion

Latent Variable	AEE	CEE	HDS	PEE
AEE	0.832			
CEE	0.890	0.856		
HDS	0.915	0.874	0.828	
PEE	0.934	0.883	0.920	0.855

Table 3 presents the correlation values for the latent variables, showing that:

HDS: 0.828 (greater than AVE: 0.684); CEE: 0.856 (greater than AVE: 0.750); AEE: 0.832 (greater than AVE: 0.692); PEE: 0.855 (greater than AVE: 0.735)

Since all AVE values exceed 0.5, the results confirmed that the convergent validity test was met, ensuring each construct adequately explained its respective indicators.

Reliability tests used in the study were composite reliability and Cronbach's alpha. A variable is considered reliable if its composite reliability value exceeds 0.7.

Table 4. Composite Reliability and Cronbach's Alpha

Latent Variable	Composite Reliability	Cronbach's Alpha
HDS	0.970	0.967
AEE	0.931	0.911
CEE	0.947	0.932
PEE	0.957	0.948

Table 4 presents the composite reliability values for all research variables, showing that they exceed 0.70. This confirms that each variable meets the composite reliability criteria, indicating a strong level of reliability.

Reliability testing using composite reliability is further validated by Cronbach's alpha. If Cronbach's alpha exceeds 0.70, the construct is considered reliable. As the Cronbach's alpha values of all four research variables are above 0.70, it is safe to say that internal consistency and reliability were relatively high.

The inner model test evaluates the structural model, assessing key components such as: path coefficient, R-square (R^2) value, T-statistic, predictive relevance (Q^2), and model fit.

The path coefficient evaluation was used to determine the magnitude of influence exerted by the exogenous variables on the endogenous variables,

Table 5. Path coefficient

Latent Variable	Path Coefficients
CEE on HDS	0.253
AEE on HDS	0.279
PEE on HDS	0.438
CEE on PEE	0.265
AEE on PEE	0.692
AEE on CEE	0.893

Table 5 presents the influence coefficients between variables in the structural model:

CEE → HDS: 0.253; AEE → HDS: 0.279; PEE → HDS: 0.438

CEE → PEE: 0.265; AEE → PEE: 0.692; AEE → CEE: 0.893

Among these, the strongest influence was observed between AEE and CEE (0.893).

R-Square was applied to measure the degree of influence independent variables had on dependent variables.

Table 6. R-Square

Latent Variable	R-Square
HDS	0.883
AEE	0.797
PEE	0.877

The R-Square value for HDS was 0.883, which indicated that 88.3% of the variance in HDS was explained by CEE, AEE, and PEE. The R-Square value for AEE was 0.797, indicating that 79.7% of the variance in AEE was influenced by CEE and PEE.

The R-Square value for PEE was 0.877, suggesting that 87.7% of the variance in PEE was affected by CEE and AEE.

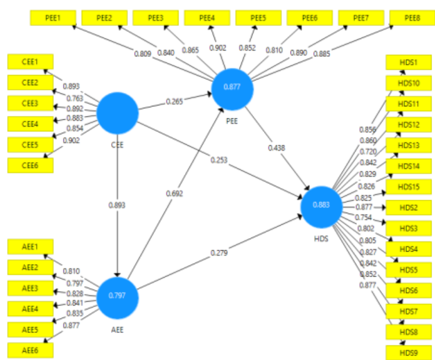

Figure 2. Evaluation of structural model

Hypothesis testing was conducted by analyzing the T-statistics and P-values. A hypothesis is considered statistically significant if the P-value is below 0.05.

Table 7. T-Statistic and P Values

Latent Variable	**T-Statistic**	**P Values**
CEE on HDS	2.156	0.032
AEE on HDS	2.423	0.016
PEE on HDS	3.393	0.001
CEE on PEE	2.145	0.032
AEE on PEE	5.799	0.000
CEE on AEE	33.945	0.000

According to Table 7, the influence of CEE on HDS had T-statistic value of 2.156, higher T-table value of 0.1672 at α = 0.05, and P-value of 0.032, lower than α = 0.05. The influence of AEE on HDS had T-statistic value of 2.423, also higher than T-table value of 0.1672, and P-value of 0.016, lower than α = 0.05. Similarly, the influence of PEE on HDS had T-statistic value of 3.393, exceeding T-table value of 0.1672, and P-value of 0.001, lower than α = 0.05.

The effect of CEE on PEE had T-statistic value of 2.145, higher than T-table value of 0.1672, and P-value of 0.032, lower than α = 0.05. The impact of AEE on PEE had T-statistic value of 5.799, beating

T-table value of 0.1672, and P-value of 0.000, lower than α = 0.05. Finally, the effect of CEE on AEE had T-statistic value of 33.945, significantly higher than the T-table value of 0.1672, and P-value of 0.000, lower than α = 0.05.

The findings indicate positive and significant effect of CEE, AEE, and PEE on HDS. In other words, the higher the CEE, AEE, and PEE values, the greater the HDS will be.

Modeling in Partial Least Squares (PLS) was analyzed by considering predictive relevance in constructive modeling.

Table 8. Predictive Relevance

Latent Variable	Q Square
HDS	0.593
PEE	0.636
AEE	0.545

Table 8 shows that the Q-square values for the model are as follows: HDS: 0.593, PEE: 0.636, and AEE: 0.545. Since all Q-square values are greater than 0, it can be said that the model has predictive relevance.

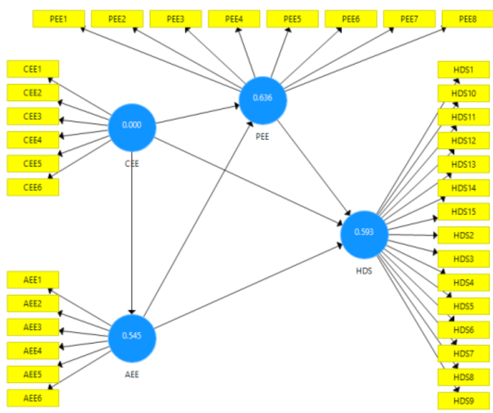

Figure 3. Predictive Relevance

DISCUSSION

The research findings indicate a positive and significant influence of Cognitive Education Environment (CEE), Attitude Education Environment (AEE), and Psychomotor Education Environment (PEE) on hydrometeorological disaster understanding (HDS). This means that the higher the CEE, AEE, and PEE, the better the students' understanding of hydrometeorological disasters. These results align with previous studies, which have shown strong relationship between perception, attitude, and environmental awareness and students' understanding of environmental pollution (Sholikhah & Shofiyah, 2024). It has also been shown in another research that population and environmental education play a crucial role in fostering positive environmental behavior, ensuring the protection of natural resources from damage and degradation (do Paço & Laurett, 2019). Other research provides conclusions supporting this study's results, including: Hydrometeorological disaster response education should begin in the immediate environment, starting with families, supported by government initiatives and relevant agencies (Sari, Khafid, & Jumadi, 2021). A shift in awareness and approach is needed to foster effective collaboration between local governments, civil protection authorities, scientists, and local communities (Lotteri, et al., 2021). The identification of various types of education—including knowledge, attitudes, and values—along with environmental influences, plays a crucial role in shaping environmentally conscious citizens (Parker & Prabawa-Sear, 2020). An individual's ability to respond to unexpected events, such as disasters, is determined by their level of preparedness, knowledge, and actions (Kirikkaya, Çakin, Imali, & Bozkurt, 2011).

Based on the research findings, Cognitive Education Environment (CEE), Attitude Education Environment (AEE), and Psychomotor Education Environment (PEE) have a positive and significant effect on students' understanding of hydrometeorological disasters (HDS). This indicates that efforts to improve HDS understanding must be accompanied by enhancements in CEE, AEE, and PEE.

Authors' Contributions

YSD is responsible for overseeing the entire research process, including planning, implementation, and the preparation of clear and comprehensive reports. DK plays a key role in designing data analysis methods, collecting data from respondents, conducting statistical analysis, and interpreting the results.

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Scopus ID : 6023041

ORCID ID : 0000-0001-7424-4583

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