IJCE, Vol. 2, No. 1, July 2025, pp. 17–25

Indonesian Journal of Chemical Education

https://journal.uny.ac.id/index.php/ijce/index

The effect of environmental knowledge and attitudes on decision-making strategies contextualized Sustainable Development Goals (SDGs) in high school student

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Article Info

Received: May 20th, 2025
Revised: Jun 20th, 2025
Accepted: Jul 21st, 2025

Keywords:

Environmental Knowledge, Environmental Attitude, Decision-Making Strategy, SDGs, Chemistry Education

Abstract

This study aims to analyze the influence of environmental knowledge and attitudes on decision-making strategies with the context of Sustainable Development Goals (SDGs) among high school students in Sleman Regency. Data were collected using random sampling technique through a survey involving 291 students from public high schools in Sleman Regency using tests to measure environmental knowledge and questionnaires to assess environmental attitudes and decision-making strategies. Instrument validity was tested through theoretical and empirical validity. The results showed that all instruments were valid and reliable. Then, the results of further tests were analyzed using the Structural Equation Modeling (SEM) method which includes the measurement model (measurement model) and strucrutal model (structural model) stages. then analyzed using Structural Equation Modeling Partial Least Squares (SEM-PLS) with SmartPLS4 software. The results of the analysis showed that environmental knowledge ($p = 0.744 > 0.05$) and environmental attitudes ($p = 0.375 > 0.05$) did not have a significant influence on students' decision-making strategies.

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e-ISSN 2581-2645

INTRODUCTION

Environmental problems have become a critical global issue (Nufus, 2020) in recent decades and Indonesia is no exception (Kurniawan & Managi, 2018). This phenomenon is shown in various forms of environmental problems, including rising sea levels (Zikra et al., 2015), deforestation (Austin et al., 2015), air pollution (Tacconi et al., 2019), plastic waste pollution (Santoso et al., 2019), water contamination due to industrial waste (Jambeck et al., 2015), and decreased soil fertility due to pollutants (Gracia et al., 2019).

Human activity is the dominant factor contributing to environmental degradation (Perkasa et al., 2017). Lack of environmental awareness and knowledge of industrial waste management based on environmental impact assessment (AMDAL) contributes to the problem (Listiawati, 2013). The complexity of these problems requires sustainable solutions articulated in the Sustainable Development Goals (SDGs) agenda.

The implementation of the SDGs requires the participation of Generation Z, which dominates the Indonesian population at 27.74% in 2021 (Aditia, 2021). Generation Z, individuals born between 1997-2012, is characterized as an digital generation that has broad access and literacy to socio-environmental

issues (Christiani & Ikasari, 2020; Hastini et al., 2020; Permana, 2021). Their significant potential as agents of change in realizing sustainable development goals has been recognized (Alfaruqy et al., 2022)

High school students as part of Generation Z (born in 2007-2009), are at an optimal phase of cognitive development to understand complex concepts such as environmental sustainability (Steinberg, 2019). This period is an important time in the formation of identity and values that will influence long-term behavior, including attitudes towards the environment (Blakemore & Mills, 2014). Therefore, the inculcation of sustainable environmental knowledge and attitudes needs to be initiated as early as possible.

The Indonesian government optimizes the role of students in the SDGs agenda through environmental education integrated in school programs (Listiawati, 2013), such as the Adiwiyata program that has been implemented since 2006 and formalized in Permen LHK No. 5 of 2020 (MOE, 2020). Several studies have shown that the adiwiyata program is effective in improving environmental knowledge (Widodo et al., 2020), environmental attitudes (Tanu & Parker, 2018), developing students' cognitive, affective, and psychomotor skills (Bahrudin et al., 2017).

The Adiwiyata program involves students in environmental management activities such as waste sorting, greening school areas, reducing the use of plastics, conserving water and energy, implementing the 5R principles, and managing waste banks (Maryono, 2015). However, empirical observations show a divergence between program and implementation, with some students not fully complying with environmental protocols (Bowosantoso, 2015; Agustin et al., 2020). Warju et al. (2018) reported that only 50-60% of students demonstrated positive environmental attitudes, indicating a deficiency in understanding the concept of environmental sustainability (Landriany, 2014) which necessitates the integration of SDGs-contextualized environmental education into the curriculum (Puk & Behm, 2003).

The integration of environmental education in the curriculum aims to improve students' environmental literacy and attitudes (Daudi, 2008). Chemistry learning is one form of implementation of sustainable environmental education (Pigozzi, 2010). The relationship between chemistry and environmental concepts can stimulate students' creativity and innovation in the resolution of environmental problems. Some chemistry materials that are relevant to SDGs values include green chemistry, electrochemistry, redox reactions, hydrocarbons, petroleum, colloids, polymers, and electromineries (Perkasa & Aznam, 2016).

Research results show that Indonesian high school students have high general environmental knowledge, but have low knowledge of global warming related (Setiawan et al., 2023). This phenomenon is caused by several factors, such as the lack of chemistry teachers' understanding of the SDGs (Kanapathy et al., 2017), the existing curriculum does not contain all relevant and essential sustainability elements (Maiteny & Parker, 2002), and conceptual complexity that hinders students' understanding (Kanapathy et al., 2017). Lack of environmental knowledge will affect the decision-making strategy process, as students with a deep understanding of environmental issues tend to consider ecological impacts in the decision-making process (Susanti et al., 2025).

Based on the above analysis, this study aims to investigate how students' environmental knowledge and attitudes influence decision-making strategies in the context of SDGs. The findings of this study are expected to significantly contribute to the development of effective educational and policy interventions to increase pro-environmental awareness and behavior, as well as sustainable and responsible decision-making capabilities among students.

METHOD

Type and Design of the Research

This research is a quantitative research through a survey analyzed by variance-based Structural Equation Modeling (SEM) method. Data analysis was conducted to test the influence between observe variables and latent variables. The observe variable is environmental knowledge, while the latent variables are environmental attitude and decision-making strategy. This research was conducted through

two stages, namely measurement model and structural model. Measurement model is used to validate the relationship between latent variables and indicators, while structural model is used to analyze the influence between observe and latent variables.

Research Sample

The samples of this study were students of XI MIPA class of State Senior High School in Sleman Regency, Yogyakarta Special Region. The sample determination was carried out by random sampling by looking at several criteria, such as being included in an adiwiyata school, having received green chemistry material, and an A accredited school. The number of samples used was 291 students.

Data Collection Technique

Data collection was done indirectly through a questionnaire. Students answer questions from a questionnaire that has been provided through google form. This questionnaire is divided into 2, namely a questionnaire in the form of a multiple choice test for environmental knowledge and a questionnaire questionnaire for environmental attitudes and decision-making strategies with a Likert scale (strongly agree, agree, undecided, disagree, and strongly disagree)

Data Collection Instruments

The environmental knowledge and attitude instruments were adapted, while the decision-making strategy instrument was adopted from Kamila's research (2025). The adaptation of environmental knowledge is taken from several studies, including Gambro & Switzky (1996), Hartman et al. (2017), Kaplowitz & Levine (2014), and Gericke et al. (2017). The environmental knowledge test instrument is a 17-item check point that covers two aspects, namely environmental issues and environmental management. Meanwhile, environmental attitude instruments were adapted from several studies, including Gericke (2018), Maloney et al. (1975), and Kaiser et al. (2003). The number of environmental attitude question items is 18 statement items with five aspects, namely sustainable attitudes, verbal commitment, real commitment, and environmental sensitivity. Then, the adopted decision-making strategy instrument has five aspects, namely define the problem, generate alternatives, think about risk and consequences, determine the decision, and evaluate the decision. More details regarding aspects of environmental knowledge and attitudes, as well as decision-making strategies can be seen in Table 1, 2, and 3 below.

Table 1. Aspects and Indicators of Environmental Knowledge Instrument

Aspects	Indicator
Environmental Issues	Energy sources used today
	Burning coal produces pollution
	Greenhouses cause a warm climate
	Three effects of the greenhouse
	Sulfur fumes from factories cause acid rain
	Metal sulfides cause acid rain
	Understand the factors that cause environmental pollution
	Knowing the harmful chemical content of pollution events
	Understand the factors that cause environmental pollution
	Ozone layer protects against cancer-causing sunlight
	Batteries are household hazardous waste
	Common methods for storing nuclear waste
	Efforts to maintain water availability

Aspects	Indicator
	Analyze the impact of environmental pollution from mining activities.
	Know the types of non-renewable resources
	Understand the advantages of recycling materials
	Understand the treatment of waste
	Understand what is meant by recycling
Environmental Stewardship	Ability to identify appropriate solutions to problems
	Recognize the interdependence between humans and the environment
	Understand the health, socio-economic, and ecological dimensions of environmental management
	Understand how environmental problems are explored and how solutions are developed and implemented.

Table 2. Aspects and Indicators of Environmental Attitude

Aspects	Indicator
Sustainable Attitude	One's attitude towards conservation of natural resources
	Evaluation of the importance of maintaining ecosystem balance
	Assessment of environmental issues such as climate change
	Impacts of climate change
	Efforts to reduce waste use in an industrial context
	Purchase of sustainable products
Verbal commitment	Measures what a person states he or she will do with respect to pollution-environment issues
Real commitment	Measures what a person actually does with respect to environmental issues
Environmental sensitivity	Measure the level of sensitivity related to environmental issues

Table3. Lattice of Decision-Making Strategy Instrument

Aspects	Indicator
Define Problem	Able to identify environmental problems
Generate alternatives	Creativity in finding climate change solutions
Thinking about risks and consequences	Able to weigh the benefits of a decision
	Able to weigh the disadvantages of a decision
	Responsible for the consequences of decisions taken
Determining the decision	Use of sustainability criteria in decision making: economic
	Use of sustainability criteria in decision making: social
	Use of sustainability criteria in decision making: environmental
Evaluate the decision	Ability to evaluate the impact of decisions on the environment
	Follow-up plan for improvement

RESULT AND DISCUSSION

Result

The measurement model results are in the form of construct and discriminant validity tests, as well as reliability testing. The construct validity value is seen from the *loading factor* value and *Average Variance Extracted* (AVE), while the discriminant validity is seen from the *Fornell Larcker* and HTMT (*Heterotrait Monotrait Ratio*) values. Both types of validity values can be seen in Figure 1, Table 4, Table 5, and Table 6 below.

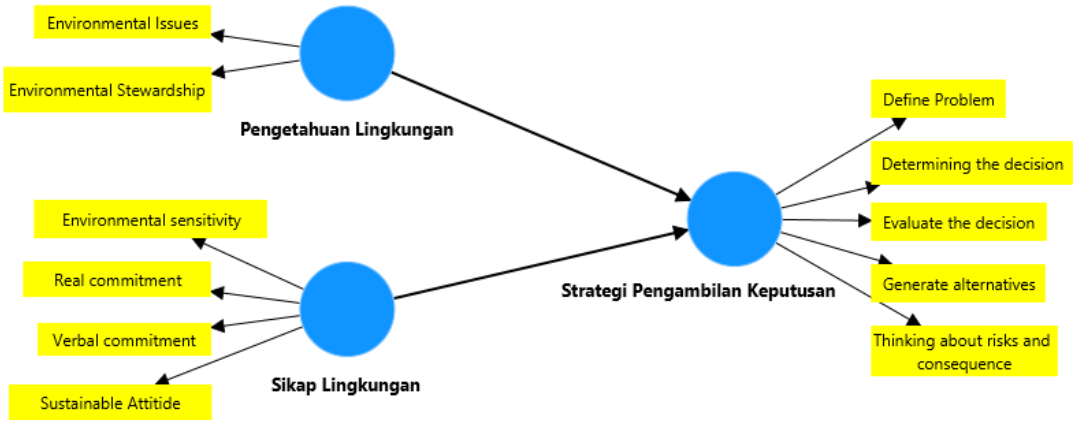

Figure 1. Dimension Level *Loading Factor* Values

Based on Figure 1, all dimensions on environmental knowledge variables, environmental attitudes, and decision-making strategies are already at the 0.5 threshold, meaning that almost all dimensions are discriminant valid. These results are in accordance with the statement of Comrey and Lee (2013) which states the *loading factor* value of 0.45 (sufficient), 0.55 (good), and 0.63 (very good). Furthermore, a good *loading factor* value is 0.60 (Chin *et al.*, 1998) or 0.70 (Hair *et al.*, 2017).

Table 4. Dimension Level AVE Values (with critical R≥ 0.5)

	AVE	Criteria
Environmental knowledge	0,619	Valid
Environmental Attitude	0,666	Valid
Decision Making Strategy	0,610	Valid

The *average variance extracted* (AVE) test aims to strengthen the convergent validity results. The minimum acceptable AVE value is 0.50 (Hair et al., 2021). An AVE of 0.50 or more indicates that the construct explains 50% or more of the variance of the indicators that measure the construct. The results of the three variables show an AVE value> 0.5, so the three variables have good validity.

Table 5. *Fornell Larcker*

	Environmental Knowledge	Environmental Attitude	Decision Making Strategy
Environmental Knowledge	**0,787**	-	-
Environmental Attitude	0,101	**0,816**	-
Decision Making Strategy	0,042	0,115	**0,781**

Fornell-lacker criterion analysis, which is a validity test that compares the correlation between variables with the square root value of the *average variance extracted* ($\sqrt{AVE}$). The *fornell lacker* criterion is

the value ($\sqrt{AVE}$)> correlation between variables. These results show that the *fornell-lacker* value obtained for each variable is greater than the other variables.

Table 6. HTMT (*Heterotrait Monotrait Ratio*)

	HTMT
Decision Making Strategy <-> Environmental Knowledge	0,040
Decision Making Strategy <-> Environmental Attitude	0,089

HTMT is the ratio of heterotrait (average correlation between items measuring different variables) to the root of the geometric multiplication of monotrait (correlation between items measuring the same variable), the accepted HTMT value is below 0.90 (Yamin, 2023). The data results of the HTMT values of environmental knowledge and attitudes are 0.040 and 0.089, indicating that these values have been met. Furthermore, reliability testing on the three variables can be seen in Table 7 below.

Table 7. *Cronbach's alpha* and *Composite reliability*

	Cronbach's alpha	**Description**
Environmental Knowledge	0,657	Reliable
Environmental Attitude	0,844	Reliable
Decision Making Strategy	0,886	Reliable

The test aims to evaluate the reliability of the constructs in the study. Reliability measurement in PLS analysis is measured by *Cronbach's alpha and composite reliability* values. The minimum value for both is 0.7 (Hair et al., 2017). However, a value of > 0.6 is still acceptable (Budhi, 2018). Based on the reliability test results, the three variables are declared to have good reliability. Structural model testing involves three tests, including the VIF (*Variance Inflated Factor*) test, hypothesis testing, and the *effect size* f *square* (f^2)test. The *output* results show the VIF value on the variables of knowledge and environmental attitudes towards decision-making strategies is 1.010 and 1.010, respectively. Inner VIF values below 5 indicate that there is no multicollinearity between variables. Meanwhile, the results of hypothesis testing can be seen in Table 8 below.

Table 8. Hypothesis Test Results

	T statistics	*P values*
Environmental Knowledge -> Decision Making Strategy	0,327	0,744
Environmental Attitude -> Decision Making Strategy	0,888	0,375

Based on the results of hypothesis testing, the p *value* on environmental knowledge and attitudes is 0.744 (>0.05) and 0.327 (>0.05), respectively. This means that environmental knowledge and attitudes do not have a significant effect on decision-making with the SDGs context. Then, the value of f^2on environmental knowledge and attitudes towards decision-making strategies is 0.001 and 0.013, respectively. Both values are low, meaning that the influence of environmental knowledge and attitudes on decision-making strategies is very low.

DISCUSSION

The p *value of* 0.744 (>0.05) indicates that environmental knowledge does not have a significant effect on decision making with the SDGs context. This finding is in line with the research of Luan et al. (2022) which states that knowledge of environmental issues does not guarantee the formation of good sustainable decision making The results that do not

show a significant effect could be due to several factors, such as the failure of students to follow the stages of systematic decision making, so that the decisions taken tend to be subjective without comprehensive analysis. The implementation of environmental education faces various obstacles, including: (1) insufficient knowledge and pedagogical skills of teachers regarding the SDGs (Kanapathy et al., 2017); (2) limited focus of chemistry materials on technological and environmental perspectives without integration of the SDGs context (Bradley, 2005); (3) lack of emphasis on the impact of environmental problems that hinder students' critical thinking (Bradley, 2005); (4) less innovative transmissive learning approaches (Papadimitriou, 2004); (5) the density of curriculum content that hinders the development of innovative learning methods (Borg et al., 2012); and (6) collaboration of innovative learning methods, 2012); and (6) suboptimal collaboration between stakeholders (Blum et al., 2017).

Moreover, the low effect suggests the need for mediating variables between environmental knowledge and decision-making strategies. Previous studies identified environmental self-efficacy (Lauren, 2016) and environmental awareness (Liu & Han, 2020) as potential mediators. External factors such as family, motivation, and social context can also moderate the relationship (Febrianto et al., 2024)

Meanwhile, the results of hypothesis testing on the effect of environmental attitudes on decision-making strategies are indicated by the *p-value*. Based on the data results, the value is 0.888 0.375 (>0.5). These results indicate that environmental attitudes have no significant effect on decision-making strategies with the SDGs context. The finding of the insignificant effect of environmental attitudes on decision-making strategies is in line with the findings of Freed (2017) which states that the relationship between the two variables is often inconsistent. The inconsistency can be explained through several interrelated factors that include several aspects, such as institutional (school environmental programs), social (student interaction with the environment), family (parents' education level), and individual (student characteristics) (Do Paco and Raposo, 2009)

When viewed in the institutional context, one of the government programs to foster students' environmental attitudes is through programs in adiwiyata schools. However, there are several obstacles that result in these programs not being implemented optimally (Wulandari, 2017). Landriany (2014) identified that the lack of student awareness about the importance of environmentally friendly schools, funding issues, as well as low support from the community and related agencies, are the main inhibiting factors. Research from Fridantara (2015) also showed that a lack of cooperation between teachers and an inadequate number of personnel in maintaining environmentally friendly facilities hindered the implementation of the Adiwiyata program. These barriers contribute to the low influence of the Adiwiyata program on students' environmental attitudes and actions.

CONCLUSION

Based on the results of the research that has been analyzed, it provides two conclusions as follows:

1. Environmental knowledge does not significantly affect students' decision-making strategies in the context of SGDs. This result is indicated by a *p-value* of 0.753 (> 0.05).
2. Environmental attitudes do not significantly affect students' decision-making strategies with the SDGs context. These results are seen from the p-value of 0.361 (> 0.05).

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